MAR 8 1921

Subscription Price:
United States and Canada, $6.00 Per Year.

Great Britain, 30 Shillings; Single Copies, 4 Shillings.
Foreign, $6.00 Per Year; Single Copies, 75 Cents.

VOLUME II MARCH, 1921 NUMBER 11

THE JOURNAL OF INDUSTRIAL HYGIENE

AND ABSTRACT OF THE LITERATURE

EDITOR, UNITED STATES
DAVID L. EDSALL, M.D., S.D.

HONORARY CONSULTING EDITOR
THOMAS M. LEGGE, M.D., D.P.H.

EDITOR, GREAT BRITAIN
A. F. STANLEY KENT, A.M., D.Sc.

Industrial Medicine and the Immigrant

The Anthrax Problem in Horsehair

A Study of Pulmonary Silicosis

Published Monthly at 1 Divinity Avenue, Cambridge 38, Boston, Massachusetts
by Harvard University Press

Great Britain: Macmillan and Co., Ltd., St. Martin's Street, London, W.C. 2

Entered as second-class matter, at the Post Office at Boston, Mass., under Act of March 3, 1879. Published monthly.
Copyright, 1921, by Harvard University Press.

EDITORS

United States

DAVID L. EDSALL, M.D., S.D.

Great Britain

A. F. STANLEY KENT, A.M., D.Sc.

HONORARY CONSULTING EDITOR

THOMAS M. LEGGE, M.D., D.P.H.

ASSOCIATE EDITORS

United States

W. IRVING CLARK, Jr., M.D.
ALICE HAMILTON, A.M., M.D.
EMERY R. HAYHURST, A.M., Ph.D., M.D.
YANDELL HENDERSON, Ph.D.
WILLIAM H. HOWELL, Ph.D., M.D., Sc.D., LL.D.
FREDERIC S. LEE, A.M., Ph.D., LL.D.
HARRY E. MOCK, M.D.
J. W. SCHERESCHEWSKY, M.D.
C.-E. A. WINSLOW, M.S., A.M., Dr.P.H.

Great Britain

E. L. COLLIS, M.D., M.R.C.S.
W. F. DEARDEN, M.R.C.S., D.P.H.
SHERIDAN DELÉPINE, M.B., C.M., M.Sc.
SIR KENNETH GOADBY, K.B.E., M.R.C.S., D.P.H.
LEONARD HILL, M.B., F.R.S.
W. J. O'DONOVAN, M.D., M.R.C.P.
SIR THOMAS OLIVER, M.D.
R. PROSSER WHITE, M.D., M.R.C.S.

Australia

H. W. ARMIT, M.D.

South Africa

W. WATKINS-PITCHFORD, M.D., F.R.C.S.

MANAGING EDITORS

CECIL K. DRINKER, M.D. KATHERINE R. DRINKER, M.D.

MARION C. SHORLEY, A.B., *Assistant Managing Editor*

THE JOURNAL OF INDUSTRIAL HYGIENE

PUBLISHED MONTHLY

VOLUME II | MARCH, 1921 | NUMBER 11

INDUSTRIAL MEDICINE AND THE IMMIGRANT*

MICHAEL M. DAVIS, JR., Ph.D.

AND

LINDA JAMES

SCOPE AND PROBLEMS

WHILE most manufacturers are probably conscious that they employ numbers of "foreigners," a few figures may make more evident the importance of giving special consideration to this group in industry today. In 1908–1909 the United States Immigration Commission made an investigation of immigrants in industries, which contains much valuable material for the captain of industry and his medical lieutenants, the industrial physicians. Jenks and Lauck (1) summarized these facts in their book, from which the following quotations are made:

> . . . Only one-fifth of the total number of wage earners in twenty-one of the principal branches of industry were native white Americans, while almost three-fifths were of foreign birth; 14 per cent. were industrial workers of the second generation, or of native birth but of foreign father; and 5 per cent. were native negroes. About 30 per cent. of all the females, as contrasted with 14 per cent. of the men, were native born of foreign father. . . . Altogether fifty-six different races appeared in the working forces of the mines and manufacturing establishments included in the recent comprehensive inquiry of the Immigration Commission. Thirty-seven of these races were of the south and east of Europe, or of the Orient. Almost one-half of all the wage earners were from southern and eastern European countries. The proportion of foreign born among the operating forces of the principal branches of manufacturing and mining were as follows: more than one-half of the iron and steel workers, employees of oil refineries, slaughtering and meat-packing establishments, furniture factories, leather tanneries and finishing establishments, woolen and worsted goods, and cotton mills operatives; about two-fifths of the glass workers; one-third of the silk mill operatives, glove factory employees, and cigar and tobacco makers; seven-tenths of men and women garment makers; more than one-fourth of the boot and shoe factory operatives; four-fifths of the wage earners in sugar refineries.

A glance at a few payrolls (Table 1) analyzed by race will make clear the variety as well as the number of foreign-born employees in factories and mining regions of the United States. Comparatively few companies keep any record of race, and of those who do not many have ever analyzed their data. The first payroll given is from a typical New England leather factory. The second is from a corporation manufacturing machinery in Ohio, Wisconsin, and Illinois. The last is not a payroll but represents the

* The material on which this article is based was secured by the authors during a study of the health problems among immigrants, made as part of the Americanization Study of the Carnegie Corporation. A portion of this material will appear as a chapter in the book on *Immigrant Health and the Community* by Michael M. Davis, Jr., Harper & Bros., publishers. The field work was done during 1918 and 1919 and the data should be interpreted with these dates in mind. Received for publication Sept. 9, 1920.

TABLE 1.—PAYROLLS OF THREE COMPANIES ANALYZED BY RACE

1

French	438	Greeks	53
Lithuanians	379	Armenians	42
Italians	362	Jewish	39
Irish	294	Russians	36
Polish	196	Scotch	35
Americans	173	Assyrians	16
English	130	Miscellaneous	73
Syrians	81		
Swedes	57	Total	2,404

2

		Per Cent.			Per Cent.
Americans, white	5,283	47.9	Japanese	1	..
Americans, colored	278	2.5	Jews	30	.3
Argentineans	1	..	Kreiner	5	..
Armenians	20	.2	Lithuanians	312	2.8
Albanians	20	.2	Luxemburgers	3	..
Austrians	294	2.7	Norwegians	76	.7
Belgians	8	.1	Persians	5	..
Bohemians	174	1.6	Poles	1,454	12.9
Bulgarians	3	..	Roumanians	12	.1
Canadians	25	.2	Russians	177	1.6
Croatians	74	.7	Ruthenians	6	.1
Danes	31	.3	Scotch	22	.2
English	63	.6	Serbians	42	.4
Finns	4	..	Slavonians	137	1.2
French	16	.1	Spaniards	2	..
Germans	810	7.4	Swedes	147	1.3
Greeks	302	2.7	Swiss	17	.2
Hollanders	216	2.0	Syrians	15	.1
Hungarians	506	4.6	Turks	8	.1
Irish	52	.5	Ukrainians	8	.1
Italians	341	3.1	Welsh	22	.2
Jamaicans	2	..	West Indians	1	..
			Total	11,025	

3

Population of thirteen towns, Mesaba Range, Minnesota(2)

Americans, white	12,000	North Italians	1,000
Finns	7,300	Poles	800
Slovenians	3,600	Slovaks	800
Swedes	3,580	Serbians	515
Croatians	3,400	Bulgarians	460
South Italians	3,300	Bohemians	315
Montenegrins	2,600	Greeks	218
Irish	2,200	Syrians	110
Norwegians	1,300		
Jewish	1,000	Total	44,498
Foreign born	73%	American	26.9%

racial elements in the iron and copper mining towns of Minnesota and Michigan.

According to the U. S. Census of 1910 (3), 59.9 per cent. of the foreign born were between the ages of 15 and 45 years. The corresponding percentage among the native born was only 45.9. A much larger proportion of the immigrants in this country are of working age than among the native born. No survey of the health problems and of methods of medical and health work among the foreign born would be complete without considering the place in their lives which industrial medicine occupies. Does the immigrant employee, because of his foreign birth, present special medical, sanitary and health problems to the industrial physician? If so, what methods of solving these problems are being tried out and with what success, and what is the interrelation of industrial medicine to the general medical service and health work of the community?

As in other branches of this study, information was secured partly by questionnaires and partly by personal visits and interviews. In planning this investigation and in securing lists of industrial physicians and others, much help was given by Dr. Harry E. Mock, Dr. George M. Price, Dr. Alice Hamilton, the Pennsylvania Health Insurance Commission and the Minnesota Department of Health. The replies to the preliminary questionnaires furnished many suggestions as to desirable persons and places to visit. Health conditions and problems vary with the location of an industry, with its character, and with the racial elements among its employees. Consequently, manufacturing establishments in large cities and in small towns, mining communities in several parts of the United States, and, finally, some mercantile establishments were visited in a number of places wherein different races predominated. The Atlantic Coast states, the regions around Cleveland and Chicago, parts of Pennsylvania, Minnesota, Michigan, Colorado, and California were included. About fifty different establishments were visited, usually five or six people being interviewed in each.

The industrial physicians, the nurses, the safety and sanitation departments, and the employment managers, were the persons sought for. Thus, this report is a survey of a variety of situations and viewpoints.

To get the industrial physician's own conception of what problems the immigrant brings to him the questionnaire method was the first used. Seventy replies were received, of which twenty-two (31 per cent.) said that housing conditions in relation to the foreign-born employee were a cause of grave concern. Twelve (17 per cent.) recognized that immigrant foods and food habits were problems. Ten (14 per cent.) mentioned the personal hygiene of the foreign-born employee in relation to factory sanitation and efficiency of the worker. Six, whose firms employed large numbers of Slavic peoples, spoke of alcohol. Six mentioned the need for instruction in English, so that health education might be of avail. Seven mentioned tuberculosis; and six, occupational diseases. A significant item was the small number (only three) who appeared to have recognized the need for dental care. Other points brought out by these questionnaires will be found in Table 2.

It is obvious that many of the problems mentioned in the questionnaires are more or less common to all employees of industry, as well as to the foreign born. But as we have seen, the immigrant is affected by the complicating influences of language, unfamiliarity with American conditions, habits of life derived from an entirely different environment, etc. Only a few of the persons who answered our questionnaires or who talked matters over in our interviews had given serious thought to the medical and health problems peculiar to the immigrant employee, or to special methods for dealing with these problems. Some of these few, however, had much to contribute, as will appear. First, let us take up certain general points.

TABLE 2. — ANALYSIS OF QUESTIONNAIRES SENT TO INDUSTRIAL PHYSICIANS JULY, 1918

Number sent out	354	
Number returned	80	
Per cent. returned	23	
Of the 80 answers received: [1]		
	Number	Per Cent.
1. Do nothing with foreign born or men in United States Military Service	10	12.5
2. Take care of accidents chiefly	14	17.5
3. Extend medical service in some degree	10	12.5
4. Place employees at work according to physical fitness	29	36.3
5. Give miscellaneous constructive suggestions	20	25.0
Of the 70 answers with suggestions: [1]		
1. Examine applicants for work	38	54.3
2. Re-examine other employees	42	60.0
3. Not examining all employees, but feel need of doing it	4	5.7
Outstanding problems as presented by the 70 questionnaires: [1]		
1. Housing conditions	22	31.4
2. Kinds and preparation of food	12	17.0
3. Personal hygiene	10	14.0
4. Tuberculosis	7	10.0
5. Alcohol	6	8.5
6. Occupational diseases (chiefly lead poisoning)	6	8.5
7. Trachoma	4	5.7
8. Bad teeth	3	4.0
9. Venereal disease	2	2.8
10. Hernia	2	2.8
11. Feel need of extension of medical service to homes	3	4.0
12. Feel need of teaching English language	6	8.5

[1] The same questionnaire may fall under more than one grouping.

We find in the responses expressions of every point of view, from the big stick theory up. Thus one doctor writes:

> There is an endless field for doing good, and we are desirous of doing our part; especially teaching these men of foreign birth to respect and honor their adopted country. Teach them how to live in their homes, and make them desirable citizens, proud to live [in the United States].

A contrast to this paternalistic approach is the following:

> If given a square deal, housed in habitations fit for humans rather than hovels and rabbit warrens, appealed to by means of pictures, talks in their own

language, and an HONEST desire to help *them* rather than as it has been — work them to death, pay as poor a wage as possible to compel them to accept . . . this is my idea of . . . what might be done to make them better physically, mentally. We MUST meet them on the level, and not from a superior height and be condescending.

The doctor who would force the immigrant to conform to our standards is well represented in the questionnaires. One physician suggests that we "eliminate as far as possible all foreign institutions"—a suggestion which comes in the same breath with "abolition of the saloon." Another doctor feels the great need of "education of the employer," if these problems are to be solved. He is seconded by one who writes that both "employer and employee must be educated, the former to spend money for a first-class [welfare] organization, and the other to accept graciously that which makes he or she a more valuable worker."

Among employment managers, the chief concern seemed to be the housing problem and the alcohol question. Since these two factors are intimately associated with labor turnover and absence from work, it is natural that the employment manager should feel the additional pressure imposed by the presence of many foreign-born employees. The teaching of English in relation to labor turnover also interested employment managers; but that lies outside the field of health, and was only touched on indirectly in our investigation.

Safety and sanitation departments in a few instances were considering the additional hazards which non-English speaking employees present. When it came to the question of factory sanitation, nearly all admitted that the foreign-born employee raised special problems, but practically none had done anything toward solution. Misuse of toilet facilities and promiscuous spitting were generally complained of as intensified where immigrants were present in any numbers.

Where the work of an industrial physician or surgeon is confined to treatment of accidents and emergencies, it is natural that the immigrant should be lost sight of in the monotonous routine of the work itself. But despite the increased opportunities for service which rapidly evolving industrial medicine is now giving, a surprisingly limited number of doctors have considered the difficulties which the immigrants present to them. As a rule, the nurses employed by industrial establishments had much more consciousness of these difficulties than had the doctors under whom they worked. This may probably be accounted for by the fact that the nurse usually sees the home as well as the employee in the factory, and therefore has a more rounded conception of the individual's life than the doctor, who is only too apt to limit himself, as well as his work, to the confines of the clinic walls. Housing, food difficulties, personal and factory hygiene, alcohol, venereal diseases, inability to secure the confidence of the employees, were among the chief difficulties which the nurse felt to be accentuated by the presence of the immigrants in a factory.

One physician, head surgeon of a very large industrial concern in New England, had been impressed by the influence of bad housing upon the physical fitness of the foreign-born employee. He advocated giving an industry complete and absolute control over the health of its workmen. He even felt that communities should deputize industrial agents as sanitary inspectors for the purpose of enforcing regulations in the homes of employees of the industries concerned. Force was his only suggestion as a solution for the problem of sanitary homes for the immigrant workman.

The following anecdote illustrates better than anything else a prevalent attitude toward the immigrant employee. It brings out the language barrier, the indifference or contempt of many native born toward the

immigrant, and the frequent lack of a social consciousness on the part of nurses and employment managers. This incident happened during the process of interviewing, and is quoted direct from the notes made at the time.

> While I was talking with one of the nurses, a Hungarian, small and dirty, and violently gesticulating and speaking broken English, came bursting in the room next ours. The employment manager stepped in from the next room to try to quell the disturbance. As I passed through where they all were, the nurses and employment manager were standing in great annoyance, laughing at this little man. He was so frantically eager to make them understand his trouble that he was weeping at his inability to do so, while they merely grinned at him.
>
> As the employment manager came into the room where I stood, I asked what the trouble was.
>
> "Oh, that man's wife is sick and he wants us to pay the meat bill" — then he laughed. How many facts lay behind that statement I could not tell, nor was any sincere attempt made to find out from the man what was the specific cause of his distress. He went out, returning in a few moments still shaken by his excitement, to find the door ordered locked against his re-entry.

Some comprehension of the European backgrounds and native characteristics of the races represented in our industries is necessary if we are to understand the problems which they are bringing to the industrial world. How can a doctor or superintendent of sanitation in a factory pretend to deal with the difficulties forced to his attention by the presence of the foreign born, if he knows nothing of their inherited ideals, customs, and standards of living? Each race differs from every other, and he who would make intelligent efforts to solve the problems brought by each race must first understand their racial heritages. Misuse of toilets and promiscuous spitting, for example, irritate and anger industrial managers. If one is familiar with the fact that many of the immigrants have lived outdoor lives and had never seen a water-flushed toilet before coming to the United States, one gets a new conception of the problem confronting him, and, what is more, a new understanding of the viewpoint of the immigrant himself. That is the first step toward intelligent corrective action. Is there an industrial physician who feels anything but exasperation at the personal uncleanliness of an immigrant employee? Does the physician, however, know what the race habits of this people were with regard to bathing, or what bathing facilities this particular man now has in his American home? To try to accomplish the best results in preventing accidents, curing disease and promoting health and efficiency among foreign-born employees, requires a consciousness of immigrant backgrounds and characteristics, combined with a knowledge of the conditions under which immigrants live in this country.

The ideal attitude of industry toward this question is given by Charles E. Knoeppel in an address before the American Society of Mechanical Engineers in 1918 (4).

> The manager of the future . . . will love men, and will work with them to make them better men. He will study men, for in the last analysis men are, and always will be, the foundation of industry and civilization. . . . Man is the foundation; therefore, know man; for a thorough knowledge of man, and of men, will be the keystone in the industrial structure of the coming age. . . .

Medical Service in Industrial Establishments

Medical service within the industrial plant for the employees is a subject of great importance in relation to the foreign born. A brief introductory history of industrial medical service will, therefore, be useful.

Most industrial clinics originated as a result of accident compensation laws. In their early history a first-aid kit was kept in the building and arrangements were made with doctors to answer calls for emergencies. The next step beyond this was the installation of first-aid stations within the plant itself, with a nurse employed full

time, and a surgeon still on call for serious accidents. Selby (5) in his study of 118 plants with clinics found that 14 per cent. had what he called "detached emergency service" — that is, doctors were summoned only in case of accident. Then there came the physical examination of the applicants for work, as well as periodic re-examinations of those exposed to industrial health hazards, such as lead. From this it was not a far step to having physicians as well as nurses present all day. Selby found that 65 per cent. of the 263 doctors in the plants he visited were full-time men. Following this, the best among these doctors and nurses, seeing the great opportunities which lay before them to be of service to the employees as well as to the industries employing them, began to broaden the scope of their work. Today the most advanced among them have succeeded in extending medical service to the homes of the workers and have installed various specialties in their clinics, such as X-ray plants, oculists, and dentists. They study health conditions and hazards in the factory, for the purposes of preventive medicine. Educational literature and health talks are also included in the activities of a few departments. Selby found four establishments with oculists. Health bulletins issued by the National Safety Council were used by 16 per cent. of the 118 places visited, and health talks were given in 12 per cent.

The idealistic attitude toward this work is well expressed by one of its distinguished leaders, Dr. Harry E. Mock, in the *Journal of Industrial Hygiene* for May, 1919 (6):

> This new specialty of industrial medicine and surgery includes every scientific branch of medicine and in addition requires a keen understanding of practical sociology. Its field is so broad that it involves specialists within this specialty — yet each worker in this field must be thoroughly trained in its general aspects.
>
> The problems of the family physician concerned the individual and the family. The problems presented to the industrial physician concern the individual, the family, and the large group associated with him — his fellow-employees and employer.
>
> Specifically the scope of this work deals with the human maintenance equation in industry. It involves the prevention of disease and accidents among the entire group of employees; the constant supervision of the health of the employees, including a study of each individual, the working conditions, the hazards of each occupation, the question of hours of labor and wages, the daily intercourse between the employer and the employed as well as between fellow-employees, and the home environments of the working force; adequate medical and surgical care of the sick and injured; compensation and benefits during periods of disability; the selection of occupations according to the physical qualifications of the individual; the restoration of the disabled to an economic usefulness; it involves, in fact, every human equation in this problem which affects the health and efficiency of the individual or of the entire group of employees.

Within this scope, what recognition has there been of the special problems of the immigrant employee, and what has been done to meet them? The best method of learning what measures have been taken toward a solution of these problems is to follow an individual immigrant through a typical industrial clinic. His first point of contact is, of course, the man at the desk in the employment office. If our applicant understands any English, he will get by there somehow. If not, some friend or neighbor may help out, or he will have to talk as best he can by signs. In one particular factory, which we are taking as example, he is then sent to the clinic for physical examination before placement at any job. Here his troubles increase. He is stripped — without knowing why or wherefore in many cases, because he cannot understand what is being said around him or to him. Then the doctor makes his examination. How common a sight it is to see doctor and prospective employee standing facing each other, helpless, with no common tongue and no common understanding of each other's outlook toward the work in

hand. How can an English-speaking physician hope to get a personal history from an immigrant who understands at best only a little English, and who speaks very imperfectly? How can the doctor explain the necessity of remedying the physical defects that he finds in such a way that the man may become a more efficient workman for the company which is going to employ him? If the employee knows a little English he may catch the words "operation," "cut," or "hospital," and terror at once may fill his soul. A casual interpreter dragged in either from the plant or from outside cannot serve effectively in a situation like this. An interpreter, who is familiar with medical and social work and who also understands the racial heritage of the man concerned, is needed. To work through an interpreter is clumsy at best; but how infinitely more difficult it is to secure results with an ignorant and untrained person who happens along and seems to know the language, than with someone regularly employed within the clinic who knows its aims and functions. The employer who neglects this fact is wasting many dollars spent on doctors for lack of as many dimes that should go for nurses, social workers, or interpreters.

If the new employee is to be assigned to a job which is hazardous from the viewpoint of industrial disease, the physician is again met with the barrier of language and the man's unfamiliarity with American industry. Poisons, protection from which means careful personal habits and cleanliness, are many times more a hazard to such a workman than to the native born. To make clear the hazard of something which the workman cannot see, such as wood-alcohol vapors, is impossible if he cannot understand the language of the instructor.

It is not at all unlikely that the man, whom we have been following through a clinic, is very dirty. The doctor's first and peremptory orders are to take a bath — not once, but frequently. Then he cannot understand why his orders are not carried out. To suggest frequent baths to an American is not such a great shock. He at least knows of our bathing customs and is familiar with city water supplies and bathtubs. But to the newly arrived immigrant such a suggestion may indicate lunacy or evil intent. Roberts (7) has cited some vivid examples of attitudes of mind which some immigrants held toward frequent bathing.

> Mr. Shadwell says of the Germans: "To any one who remembers the Germany of old, when no one could swim, bathing was thought a proof of insanity, and washing a dangerous eccentricity — no change is more remarkable than the conversion in this respect."
>
> A young Pole was induced to go into the swimming pool in a Young Men's Christian Association; after that he kept away from the building, and the secretary went to find out why he stayed away. The mother of the lad met him, gave him a piece of her mind, that he dared make her boy take a bath in winter time. "Did you want to kill him?" Thousands of immigrants from southeastern Europe do not appreciate the value of personal cleanliness.

Another very important way in which the industrial physician can aid his employer to reduce disease and accident is to make an entry of mother tongue and nationality on his medical records, and then analyze statistics by race. The making of the original entry may be the duty of the employment department, but the medical department should know and utilize the facts, a thing which so few industrial clinics do, that this point cannot be too strongly stressed. Among our field notes on industrial interviews we frequently ran across such entries as this:

> Nurses had no knowledge of races in plant, number of employees, nor of diseases or accidents by races. Never analyzed their records. Struck them as new idea. Did not even know that there was a place on their medical record for nationality entry. No knowledge of plant conditions or hazards.

A few doctors with the analytical type of mind have already included on their med-

ical records data in regard to nationality and have utilized the information, to the great advantage, not only of the company employing them, but also of our growing knowledge of the specific problems to be met. For instance, one of these men found by analysis of his records that hernia occurred more commonly among the southeastern Europeans employed by the company—Italians in particular—than among other races doing the same kind of work. The marked prevalence of rickets among Italian children, both in Italy and America, interested him greatly in this connection. His next step in regard to this observation, which grew out of careful analysis of records by race, will probably be a study of food habits among the Italian employees. This same doctor has noted more pernicious anemia among Swedes than among the southern European races. So he will go on analyzing the data secured day by day in the routine work of the clinic. This knowledge he applies at once to the practical demands of his industry. He is making scientific contributions to our imperfect knowledge of the problems brought to industry by the immigrant. There is a great need for more extended study of this kind so that industrial physicians hereafter may have sound statistical material on which to base action relative to foreign-born employees.

It has already been pointed out that the large majority of workers in railroad and construction camps are foreign born. Medical service for such "floating labor" is in a sadly undeveloped state. These workmen live in temporary camps at certain periods of the year, but many come to the cities to spend the winters. The provision of medical facilities for immigrants in little isolated lumber or ice camps is important to the state as well as to the individual. These men are often sources of infection because they spread contagious disease as they travel.

In Wisconsin, Leiserson (8) found that hospital and medical facilities were lacking in most camps. In two camps he found a deduction of fifty cents made from the employee's pay envelope for hospital fees. Sometimes there were hospitals not far from the camps, but often it was very difficult to get medical care. This meant that an ill man was shipped out of camp to find his way to medical aid alone. Inquiry was made, at this time, of hospital and health officers in the state relative to the cases of disease which could be traced to these labor camps. The results of the investigation indicate that the camps are a menace to even far-distant communities. Of the fifteen cities which replied, seven had kept more or less complete records of place of origin of contagious diseases during the preceding three years. The following cases were claimed to be directly traceable to insanitary camp conditions within Wisconsin: typhoid 159; smallpox 12; diphtheria 6; others 28 (measles 5, scarlet fever 3, meningitis 1, erysipelas 19). The greatest number of cases of contagious diseases were reported from lumber camps, the railroad camps ranking second.

In Minnesota the large lumber companies usually provide for medical service through the "contract system." The contract surgeon is located at the nearest town of any size, and either the men are shipped out to him when ill or he goes to the camp. There are good hospital facilities on the Mesaba iron range to which the men can be taken in case of accident. Contagious diseases, however, offer the same problem here that they do in Wisconsin. The Division of Communicable Diseases of the Minnesota State Department of Health has on record many interesting cases of typhoid fever associated with temporary labor camps. Such lack of attention to the medical and health problems of the labor camp is a serious one for the public welfare, and for the efficiency of industry as well.

It can be adequately dealt with only by state and, in some cases, by federal authority.

A few industrial physicians have extended medical service from the plant itself to the homes of the employees. The value of such service to the immigrant and his family is great, especially if obstetrical care and medicines are included. Not all physicians are, however, agreed as to the advisability of doing this. It is contrary to the policies of such representative plants as the Norton Company in Worcester and the Goodrich Company in Akron, Ohio, the doctors in which feel that the industrial physician should not infringe on the private practice of others in the community. Both plants are, however, located in large cities where other medical facilities are numerous. Endicott Johnson and Company of Endicott, N. Y., practise exactly the opposite point of view. They have three nurses for visiting the homes and another three for clinical activities. Obstetrical services are given free, as well as eye, ear, nose and throat treatment for families of employees. Their visiting nurses make both prenatal and postpartem calls.

Apparently the attitude of a company toward this question is guided to a large degree by the size of the community where it is located and by the other medical resources which are available in the vicinity. This question of the relationship between industrial medicine and community medical service is more fully discussed in the description of industrial medicine in the mining regions. The boundary line of responsibility is a delicate and changing one and decision requires careful analysis of the environment of any industrial establishment which may be under consideration. In most places where physicians employed by the industries are the only ones available, it is of utmost importance to the immigrant employee that his family have access to the doctor's services. Moderate prices mean more prompt medical care and this, in turn, means reduction in time lost because of illness of the worker or his family. Not only this, but nursing aid extended to the homes has great value in any locality.

The nurse is a means to a definite end when dealing with the immigrant. Probably she, more than any other person, has the most welcome admission to the homes of the foreign born. She comes on errands of mercy and helpfulness. Her mere presence brings much relief from worry to the immigrant and thus raises his working efficiency. That is one reason why it is so disastrous for an industry to use a nurse as a truant officer in following up absences among the immigrant workers. They soon feel that she whom they have turned to as a friend in time of illness has become a spy and intruder in their family life. Resentment, of course, results at once, and kills all the opportunities which the nurse had to carry out educational work in connection with her friendly aid. Hers is the chance to help the immigrant to adjust his food habits to the demands of the American life and so increase his working capacity; to teach him American standards of hygiene and sanitation as they apply to both the factory and home; and, lastly, to spread knowledge as to the proper care of his children who are to be the workmen of tomorrow.

The extension of medical service by means of nurses from an industry to the homes of its employees may be one of the most valuable aids to Americanization. It must be done so that the immigrant is not made to feel in any way that his private affairs are being intruded upon. Only by slow winning of his confidence and by respecting the trust he shows, can extension of medical service be made of value to him and to the industry which employs him.

There are a number of accident and sickness insurance schemes for the employees of an establishment, which are

found in concerns having many foreign-born employees. Notable is that of the International Harvester Companies, whose employees' benefit association dates from 1908. Over 50 per cent. of the employees are said to be of foreign birth. Sick benefits, disablement benefits, and death benefits are provided from a fund made up by contributions from members of $1\frac{1}{3}$ to $1\frac{1}{2}$ per cent. of wages, plus certain contributions from the companies. The board of trustees is chosen half by the employees, half by the companies. Medical care is not furnished. The average percentage of membership from the manufacturing plants during 1917 was 78.4 per cent. Large numbers of foreign-born employees are included. Even this plan — certainly one of the most successful of its kind — does not assure competent medical service at reasonable rates. The employee receives as sick benefit half his usual weekly wage, and is required to take care of himself "and have proper treatment." How to pay for doctors' fees and medicines in addition to the regular living expenses of the family, on half the usual income, must usually be a hard nut to crack. Plans of this type are a definite help to many families, but do not in any way solve the problem of providing adequate medical care. Most such plans involve much less participation by the employees than does the one above described.

In addition to industrial medical service supported by the employer, there are several plans existent among the workers themselves. The Joint Board of Sanitary Control in New York City furnishes perhaps the most prominent example. This organization, of which Dr. George M. Price is the director, is managed and supported by workers in certain women's garment trades of New York City. This board touches the lives of over 75,000 workers in more than 2,700 industrial establishments. Through these employees in the clothing industries of New York, who are united under the protocol of peace, the board supervises conditions of safety, sanitation, and general conditions relating to health in the factories where its members are employed. It seeks to enforce standards "not by police power or compulsion, but by education, co-operation, and educational persuasion" (9). In 1912 a clinic was established for voluntary examinations of all workers in the industry. Through it are directed the supervision of sick benefits paid by the locals of the union. The unions also pay for sanatorium treatment for members suffering from tuberculosis. Nose, throat, eye and ear and dental clinics are included among the services provided. "The main significance of these clinics lies, of course, in the fact that they are conducted, financed and managed by the workers themselves, for their own benefit" (9, p. 50). As large numbers of the garment workers are Jews and Italians, either foreign born or the first generation here, it is evident that such an organization bears a close relation to the problem of medical care for the immigrant. Only a minority of the members, however, appear as yet to make regular use of their clinics.

Still another phase of industrial medicine with which the industrial physician should be familiar is to be found also in New York City. Dr. Louis I. Harris, of the New York City Department of Health, established a relationship between the unions in the city of New York and the Division of Industrial Hygiene, known as the Labor Sanitation Conference, a detailed description of which is given in the Monthly Bulletin of the Department of Health of New York City for June, 1917 (10). This was an endeavor to associate labor unions and a city department for the common end of improving general health conditions in the factories of the city. Education both of employees and of employers was a prominent part of the work. The police power of the city department was used when need arose, while the

750,000 members of the affiliated unions acted as voluntary inspectors for the department. On one occasion, the department conducted physical examinations on a voluntary basis for union members. These were largely foreign born.

Such plans, to be successful, require the voluntary co-operation of all workers concerned. This involves an immense amount of educational work if the immigrants are ever to respond to the advantages offered. Most of the foreign born are not so much interested in health as they are in personal illness. Sickness makes them think of the health they have had, but so long as they are well it is very difficult for them to appreciate the need of preventive work and that is the problem in which these organizations in New York City are ultimately interested.

It should be apparent that such plans for co-operative medical service by and for employees will not supersede the well-developed clinic in an industry. Many medical and sanitary problems are closely linked with the individual factory and can best be dealt with inside of the factory. Such a clinic should maintain supervision of the conditions under which the immigrant works and of his health, and directly or indirectly should see to it that medical care for the worker and his family is available and within his means. Whatever tends to keep workers well, tends also to stabilize labor conditions. Good medical service to employees means also service to employer.

Dr. Otto Geier, a physician of many years experience in industrial medical service, writes that:

> . . . The industrial dispensary will lessen disease, increase the number of working days as well as working capacity, and thereby increase the purchasing power for adequate medical service for the families of the workers. Medical care in industry is not a charity. It pays the best dividends of any department in business. It secures a new arm to the health department and makes possible preventive medicine on a scale yet undreamed of. Witness the reduction of 75 per cent. of the time lost on account of illness in the employees of the Norton Company who use the medical department. In attacking directly such problems as personal hygiene, bad housing and living conditions, alcoholism and venereal disease, it will make a real contribution to national health and social welfare (11).

Industrial Medical Service to Communities

Nearly all of the industrial clinics are supported entirely by corporation funds. The employee is a recipient of something which he may or may not welcome, the burden of the support of which he in no way shares. In a very few instances, as we have seen, the workers themselves have initiated something in the way of medical care. In a few other cases, the employer has extended medical service outside of the plant to the employee and his family in their home. In certain mining regions, however, the service extends far beyond this.

The data which follow were secured by visits to the Mesaba and Vermillion iron ranges of Minnesota and the copper range on the northern peninsula of Michigan. Several towns were visited on each range.* The medical service for the community at large and for the industries is so closely interlocked that the description of one necessarily involves the other. In each town visited an attempt was made, first, to study the health problems presented by the most numerous races; second, to study medical service connected with the industries; and, third, to find out what medical facilities were available to the whole population so that the value of this type of industrial medical service could be fairly judged.

Data were secured by personal interviews with "contract doctors," foreign physicians, the superintendent of a mining company, school nurses and school doctors,

* In Minnesota: Ely, Virginia, Hibbing, Buhl, Eveleth; in Michigan: Calumet and Hancock.

health officers, heads of lodges and secret societies, and from nurses and social workers. Personal observation of housing conditions was of assistance. In these mining towns, the industrial group and the community are substantially identical. The medical service developed by the mining companies for their employees is practically all the medical service there is for anybody. It is community medicine under industrial auspices. Since 75 to 93 per cent. of the people on these ranges are of foreign birth or stock, the problems of the health and medical care of the immigrant are largely involved.

Of the regions visited, the copper range in Michigan is the one which has been longest worked — sixty years at some of the old shafts. The Mesaba iron range is a development of the last twenty years. According to the Report of the U. S. Immigration Commission in 1909 (2, p. 83), the Finns were the first foreigners to be employed. The Cornishmen, who were skilled miners in the "old country," came next. Since about 1900, the Poles and southeastern Europeans, Italians, and "Austrians" (chiefly Croatians and Slovenians) have been coming in greater and greater numbers. The Finns, nevertheless, still outnumber the others. There has been a steady westward migration of all these races, first to the Vermillion iron range, then to the Mesaba, and then on to the Montana, Colorado, and Arizona mines. Demand for skilled labor, higher wages, and strikes have been factors in causing this westward movement. Many of the Finns leave the mines and become farmers. Today the chief races which are involved in the system of medical service about to be described are the Finns, Slovenians, Croatians, and Italians. Different races predominate in different towns, but all are represented in each.

The kind of mining, to a certain extent, determines the racial constituents of the population. Where skilled miners are required, in the underground workings of the Vermillion and copper ranges, there will be found larger numbers of Cornishmen, Scandinavians, Irish, and Americans than in the open pit mining on the Mesaba. In the unskilled positions on all ranges are to be found the Finns, Slovenians, Croatians, and Italians.

These mines when first opened were in a wilderness. The companies had to build houses for their workmen, provide water supplies and sewage systems, take care of garbage and ash removal, and maintain the streets. Today, on the copper range, these activities are still controlled by the companies to a large degree. On the Mesaba range, houses are still owned by them, but the other activities have been taken over by the towns themselves. That the housing conditions around the open pit mines are very bad is universally acknowledged. These mines are always being extended so that the workmen who build little shanties close to the pits at the mining "locations" have to move repeatedly. The companies are unwilling to invest much capital in such temporary structures, and the people find it inconvenient to live in the towns a half mile or more away. Bad housing conditions are claimed to be one of the causes of the great amount of tuberculosis found among the Finns in these shifting towns. One can picture the transiency of the "locations" when one realizes that the whole city of Hibbing (population about 9,000 in 1919), with its paved streets, brick public buildings, and business blocks, is being moved away *en masse* to allow for open pit mining under its site. Already the enormous crater of the mine yawns close to the heart of the business section. The mining companies on the copper range, where a mine mouth is fixed for many years, have provided good houses for rent for most of the workmen. There are, however, conditions of overcrowding there also. These

towns have public water supplies either from lakes or deep driven wells, and complete sewerage systems. Other public health activities are but little developed. The reasons for this can perhaps be found in the so-called "contract system" of industrial medicine, so widely used on these three ranges. This system is said to have been imported with the Cornishmen in the early days of the development of the copper mines in Michigan. It was claimed to be impossible to keep doctors in the newly opened mining regions unless incomes were assured them. The system has been employed on each of these three ranges in turn, as they have been opened to development. The Mesaba range gave excellent opportunities to study the system from all angles of approach, including its effect on community health work, and is, therefore, the first one to be described although, in order of development, it is the most recent.

Since one object of the contract system is to assure an income for the private physician who practises on the range and so takes care of the miners, the companies have employed the arbitrary system of deducting, for this purpose, a certain amount each month from the pay envelope of the employee. The amount has varied with the years, with the companies, with the towns, and with the marital condition of the employees. In general, it may be said to range from 75 cents to $1.50. It is one of the conditions of employment, and the workman has no choice about it. The industrial contract doctor today gets altogether from $1 to $2 a month for every man employed by the companies for which he acts as contract surgeon. He takes his chances on the fluctuations of the number employed. Some years he loses and some he gains.

In the days before compensation laws were known, an additional amount of 25 cents a month was deducted from the pay envelope for a sick benefit fund, which paid $1 a day benefit for two to three months; but since the employer has been made responsible for accident care and compensation, this deduction has been stopped by most companies, although payments from accumulated funds in a few treasuries are still going on. Before the compensation act, the deductions were the only guaranteed income for the doctor. Since its introduction, the mining companies pay in addition from 30 to 50 cents per man per month to cover accident treatment, for which they are responsible in the eyes of the law.

In addition to the benefits mentioned above, most of the foreigners — "Austrians" especially — belong to their own societies, sometimes secret, which pay sick benefits. One of these (membership 175 and dues $2 a year) pays a sick benefit of $1 a day. It contracts, for $1 per member per year, with a doctor who gives medical service to members only. We were repeatedly told that some of these men belong to so many societies that when they are ill or injured they receive more money per day than when they are working.

What are the responsibilities which the doctor undertakes when he accepts this fee from the company? Accident care, of course, including hospitalization, if that is needed, free medicines, medical and hospital care for the man and his family, including obstetrical services, are part of the responsibility. Dental care is not included, nor fitting the eyes with glasses. For all but the first two, there are small additional charges made for board in the hospital, for operation or conditions arising outside of the line of employment, and for obstetrical care ($5 to $10). To meet these obligations, the physicians in nearly all cases have equipped their own hospitals, so that in towns of from 8,000 to 10,000 population as many as three hospitals of twenty to thirty beds each is not an uncommon

sight. Most of these are old houses which have been adapted to hospital uses, but one was a new fireproof building constructed for this special purpose. One of the companies is building a large hospital which will be rented to its contract surgeon. Most of the hospitals are well equipped with X-ray machines, good operating rooms and laboratory facilities, though the state department of health does a great deal of this work for them. Each hospital has its own pharmacy for distribution of free medicines.

The contract surgeon in all cases employs one or more young assistant doctors and nurses for hospital work, but not for home visiting. There are no internes such as are found in hospitals in other communities. On this range, the doctors do most of their work through home visits, and have developed dispensary methods but little. The tendency among the best contract surgeons is to develop specialties by employing specialists, such as surgeons, laboratory technicians, oculists. Only a very few companies have new men examined before employment, and then for the purpose of elimination, in most instances. There were one or two striking examples of doctors with a vision of the broader purposes of these physical examinations. The prevailing sentiment among industrial managers and contract doctors seemed to be that corporations on this range fear to inaugurate physical examinations because of the opposition which they might arouse among the laboring class. There are no unions on any of the three ranges, although there have been severe strikes in the past few decades when labor has attempted to gain recognition of the right to collective bargaining. At present the open shop and "suppression of unionism" principles prevail.

The contract surgeons take private patients, also, at the rates established by the Mesaba Range Medical Association.

Prescriptions	$1
Consultation at office	2–10
House visits (7 A.M.–10 P.M.)	3
Mileage per extra mile over a stated district	1
Night visits	4–5
Consultation visits	5–25
Minor surgical operation	5–50
Reduction of fractures and dislocations	50–100
Confinement cases	25–50
Operation for tonsils and adenoids	25–50
Major surgical operations	100–500

In the larger towns of this range, there are also doctors practising privately who are not contract men. Their clientele is drawn chiefly from among the merchants, clerks, and farmers. A number of the doctors are Finnish. The contract men are American trained and usually of British descent. The population per doctor in two of the Mesaba range towns is only 500. Since the chief industries here are mines which employ the immigrants, the greater proportion of the foreign population comes under the contract system. The railroads and lumber companies have similar arrangements for their men. These three industries are practically the only ones on this range. In a number of towns, the municipal employees are under the contract system, also, by their own request.

On the Vermillion iron range at Ely the financial arrangements are much the same, though perhaps the rates are a little higher. There are no doctors in the town other than the contract men who do private work also. These men are located at the one hospital which is there, and take care of most of the mining work on this range. The municipal employees come under the system likewise.

On the copper range in Michigan, the financial arrangements differ slightly from those on the other ranges. The physicians are employed by the mining companies on salaries, and the hospitals are either built by the companies themselves, or else dispensaries are maintained and use is made of community hospitals. Fifty cents to $1 a month is deducted by the companies from

the pay envelopes of the miners. The doctors perform the same services as they do on the Mesaba range, except that here they lay emphasis on dispensary work rather than on home visiting and hospitalization. One of the big companies, employing about 4,000 men, has an average of ninety outpatient visitors a day. Prescriptions filled at the hospital drug store amount to 80,000 a year. In peace times, there are nine doctors on the staff, all full-time men. The thirty-bed hospital has six trained nurses and eleven student nurses. Obstetrical care is free, except for a nominal charge for board. The sickness benefit fund, here known as the employees' aid fund, is supported by monthly deductions from the pay envelopes of 25 cents or more. Before the days of accident compensation laws, the company used to put into the fund each year as much as the men, but that has now ceased. In war time the aid was $1.50 per day, but in normal times it is $1. The fund is administered by the company.

One of the industrial physicians on this range is laying stress on dispensary work and home visiting with the aid of nurses. His tendency is to develop the work into preventive medicine rather than to keep it entirely in the treatment stage. For hospitalization, he uses a private hospital in the town. He examines all new employees for the purpose of placing them where they are best fitted to work, and does not simply eliminate the unfit. The men are not unionized on this range either, but, according to this doctor's testimony, there is very little objection on the part of the men to the examination, and if the men thoroughly understand its purpose, he believes they never will object. "To my mind," said our interviewer, "the delightful and sympathetic understanding of the workman's viewpoint, which this very exceptional doctor possesses, accounts for the men's attitude towards his work."

Opinions as to the value of this contract system of industrial medicine differed widely, depending on whether the person interviewed represented the employee or the employer. Representatives of the mining companies generally seemed to regard the system as "welfare work." This was also the point of view of most of the contract surgeons. They felt that they were doing good to a helpless and ignorant group of foreigners who would suffer greatly if the system were dropped. That the employees were compelled to finance the scheme under company administration seemed to most of them perfectly just. There seemed to be some question on their part as to the companies' continuation of the system, the reason for which probably lies in the attitude of the workmen toward it.

Many of the miners apparently give no thought to the system, but accept its advantages without question. There are many, on the contrary, who regard it as one of the righteous causes for the labor unrest that is to be found on these three ranges. The presence of such large numbers of Finns in this region is an important factor to consider in estimating their reception of the system. They have been radical socialists in Finland for many years as a consequence of the long struggle for freedom from Russian injustice. The "Reds," who are the radicals, and the "Yellows," who are more moderate, come to these mining regions where they find in the autocratic management of the industries new fuel for their propaganda.

The one-sided method of support of the contract system, autocratic administration of funds, and lack of choice of a doctor are a few of the things which serve to fan the flame of protest against the contract system. Accusations of a poor grade of medical care were also made. Some claimed that employees were hurried back to work before they were able to go. This remark

coincides very closely with that of some of the doctors, to the effect that, in order to justify their existence to the mining companies, it was necessary to keep men on their jobs. Only two of the contract surgeons regarded themselves as employees of the workmen. Since they are all responsible to the companies who engage and discharge them, their first effort is to satisfy their employers.

The contract surgeons held varying views as to the value of the system. Some thought it was an excellent thing for all concerned, offering exceptional opportunities for medical care in a region which would be very badly off without it. Others regarded it as a means of receiving an assured income with a minimum amount of work. The first group was made up of the progressive men who were trying to develop the very best of medical service. Some bore the same relation to the employees that the family physician bears to his patients in private life. All but one were agreed that they were obliged to do much unnecessary work because the men tended to abuse their right to free medical care and drugs. The second group consisted of the commercial type of industrial doctor who required other incentives to good work than service to the families entrusted to his care. With financial competition eliminated, such men retrograde, and the employees suffer in consequence.

Foreign doctors practising privately and in no way connected with the mining companies seemed to feel that if properly directed and democratically organized the system would be a benefit to their countrymen. Their other criticisms were much the same as those of the workmen. By them also the present arrangement was felt to be one of the causes of the strained relation between the companies and the employees, which could be felt on all three ranges.

Community health work on these ranges, where this system of industrial medicine is so universally used, is only slightly developed. Since other municipal functions, like the schools, are so advanced, the unequal development of the contract system and the city health departments seems more than a mere coincidence.

The Mesaba range again offers the best chance to study this relationship. In most of the towns here, the health officer is a part-time man, frequently the chairman of a board of health as well as a contract surgeon, and occasionally a privately practising physician in addition. His chief public function is to take charge of the contagious hospital, if the town has one; if not, he supervises contagious diseases in the homes. Charity sick cases are turned over to the county "poor doctors." Vital statistics are supposedly kept by the health officers, but with the exception of one or two towns the records are very incomplete, and have never been analyzed. None of the boards has even issued an annual report. These men are paid $100 to $200 a month. There are a few towns which are making real efforts to secure an up-to-date health department, but only one of those which I visited had a doctor who acts both as health officer and school physician, and gives his whole time to the work. His salary is paid by both the school and health boards. Last year, his department received an appropriation of $20,000 in a town of 9,000. This was the only town really able to do progressive work, since the part-time men are too handicapped by other responsibilities.

A number of the towns employ a "city nurse" who does all sorts of miscellaneous work, such as follow-up of tuberculosis, care of charity cases, attending to isolation of contagious diseases. She is always a full-time nurse. The only other home nursing facilities in these towns are the school nurses.

The public schools on these ranges, particularly those in Minnesota, are the

most highly developed of all the municipal responsibilities. Most of the schools are provided with doctors and nurses, and one town (Buhl) has employed a school dentist until very recently. It is their aim to examine all pupils at least once a year, although the war has greatly interfered with the attainment of this ideal. Eye specialists are brought from Duluth whenever there are enough children in need of treatment to justify the expense. Dental needs are largely uncovered, although a number of towns are intending soon to employ dentists for schoolchildren. Physical defects are followed into the homes, and attempts made to have them remedied, usually through the contract surgeons who have the care of the families. Some of the school doctors remove tonsils and adenoids, and some are able to fit simple glasses. Very little health educational work is done except incidentally. For instance, one doctor distributed monthly health leaflets to the teachers for work with their classes.

Perhaps the most wide-spread public health education in the schools was furnished through the weekly and daily baths given at the schools to the children who needed them. The buildings are nearly all equipped with showers for this purpose. The nurses claim they can detect some influence in the homes of this kind of education and of the example of the exquisitely clean toilet fixtures to be found in all the school buildings.

Of private health organizations other than the secret societies and contract surgeons, there are none locally. The county and state tuberculosis associations and the infantile paralysis department of the state board of health are at work in these towns. The range is inadequately supplied with dentists, there being one to about every 2,500 or 3,000 people, and none in public employ. Union dentists, a syndicate type of organization radiating its work from Duluth, are to be found everywhere. They advertise extensively bridge work and crowns — work which is sent to Duluth to be done.

Midwives are to be found in all the towns, but they do not play an important rôle in the medical situation. Some are Austrians, a few are Finns, a few Scandinavians, but there seem to be no Italians. The kind of services given varies from housekeeping, in addition to delivery, to purely obstetrical work, depending on the degree of skill or training. Most of these women are of the "practical" type, or of the type known as "neighborhood women." One Finnish midwife, who is a graduate of a European school, had a reputation for doing very good work. The rate charged varies also, but is usually $10 or $15. The ease and cheapness with which obstetrical care can be obtained through the contract surgeons seem to be factors in lessening the popularity of the midwives in these towns.

Chiropractors are omnipresent on the Mesaba range. The similarity in the appearance of their local advertising makes one suspect that there may be a commercial combination binding them all together. Itinerant oculists are occasionally seen at the hotels. Very rarely now do patent medicine vendors wander the streets as they used to do ten years ago. These types of medical quackery are much more prominent on the Mesaba range than on the other two ranges. It is the wealthiest one of the three and most recently opened, thus perhaps attracting this kind of "easy money" seeker.

The public health work on the copper range of Michigan is in a still less developed stage. The township of Calumet, for instance, has its own township government which is closely linked with that of the mining company there, flanked on either side by incorporated villages within the township limits, which grew up around saloons just outside the mine property, and

all of which together cover not more than a square mile. Both villages and township have their own separate officials, which means that there are three part-time health officers having jurisdiction within this small area. To produce unity of action in the influenza epidemic the state health department had to step in. There is no city nurse here, no school doctor, and no school nurse, although once there was one. A Finnish and a Russian doctor, as well as several native doctors, are practising here privately.

Dental needs are fairly well supplied, there being one dentist to every 1,500 population — a much better record than the Mesaba towns show. There are no union dentists. Chiropractors are present as usual, and occasionally patent medicine vendors are seen. On all three ranges, the Finnish, Scandinavian, and Italian newspapers carry their usual large amount of patent medicine and quack advertisements.

The system of industrial medical service in these mining communities of Minnesota and Michigan may be compared with that in other mining regions in the United States. Recent reports by Dr. Emery R. Hayhurst, made for the Ohio and the Illinois Health Insurance Commissions, show a marked contrast with the conditions in the northern states.

> Medical practice in mining centers in Ohio is maintained by a set of steady, hard working native American physicians, few of whom engage in contract practice. Fees charged miners are the same as those charged other members in the community. These rates do not vary much from one end of the coal field to the other, and are lower than in the rest of the state. In general, there is a shortage of physicians in mining districts which at times becomes acute because of the inaccessibility of the community. Trained and practical nurses are almost unknown persons in the mining districts. Diagnostic facilities are meager and most laboratory work is sent to the larger cities. If laboratory and hospital facilities were at hand, more scientific medicine could be practised in these districts (12).

The contract system is much less frequently used in these regions in Ohio than in Minnesota and Michigan. Dr. Hayhurst refers to medical quackery, which he found flourishing. His conclusions regarding the mining regions of Illinois are similar:

> As is well known, contract practice for so-much-per-man-per-month is looked upon with disfavor by county medical societies. This feeling seems to be shared by the local unions also. As a result of this disfavor, contract practice is less extensively found than formerly in the mining districts. Of the fifty-three physicians interviewed, three maintained a contract practice on the basis of $1 per month per family, or 50 cents per month in the case of single men. . . . Housing conditions, community neglect, bad forms of recreational hygiene and especially alcoholism, undoubtedly constitute the chief causes of most sickness. This whole situation is due largely to the inadequacy of community health organization and prophylactic measures against diseases (13).

It is apparent that for one reason or another, probably largely because of the greater age and further communal development of Illinois and Ohio, the identification of the industrial medical service with the community medical service is much less complete than on the iron and copper ranges of Minnesota and Michigan. The proportion of foreign born is less in Ohio and Illinois. Dr. Hayhurst notes that organization among the workers themselves for protection against disease and death is much more frequent among the foreign born than among the native born. It is evident that the diminution of the contract system of practice in the mining regions of Ohio and Illinois has not yet led to an adequate development of community facilities for medical and health work. It is a fair question whether the almost complete identification of medical and health work with industrial medical service, as found in northern Minnesota and Michigan, is better or worse for the people as a whole than the conditions reported by Dr. Hayhurst in Ohio and Illinois. Without doubt, the control of medical practice by the mining corporations under the contract system on the iron and copper ranges in

Minnesota and Michigan raises a serious industrial question, or at least is one of the factors entering into local issues between employer and employee. The employees are taxed to bear the expense of a system of medical service without having representation which would enable them to share in determining its policies and administration. If this medical service were wholly within the industrial establishment, the issue would be less far-reaching than in mining communities where industrial medical service is practically all the medical service there is. When to the problems thus raised is added the further complication that a large proportion of the employees are foreign born, we have an important issue of practical policy. How far should the industry go in providing community medical service? How far should employees, particularly if foreign born, be given a share in the determination of this question, in financial support of whatever system is established, and in co-operation with its administration?

This question has been met in other mining regions on a practical scale. In certain mines of western Pennsylvania and of Colorado some approaches toward more democratic organization and management of medical service are already in operation among a population largely foreign born. These plans have, therefore, been described in sufficient detail to illustrate the methods employed and their value as judged by some of those who are directly concerned with them.

In the Monongahela Valley, Pennsylvania, the miners are chiefly Russians, Poles, Slovaks, Croatians, Hungarians, Lithuanians, and Italians. Consequently, the question of medical service in that region relates almost entirely to the immigrant workmen. This valley is strongly unionized, the eight-hour day prevails, and according to the testimony of the industrial managers "things are run pretty much as the unions please." On the day the valley was visited, the mines were shut down while the men had gone off to a central town to celebrate "John Mitchell Day" in commemoration of their securing the eight-hour workday. At this time, their slogan was "Six hours and more pay."

The town of 3,000 people, which was visited, is one of two towns close together owned by the same company. There were three mines, close by and within its borders, which were being run only part of the week, due to a slump in the market for coal. The coke ovens of the old open type, discharging poisonous fumes into the air, together with the smouldering dumps at the mine mouths, filled the atmosphere with smoke and gases. The half-dead appearance of vegetation in all regions where coke is made testifies to the hazard of health near these ovens. What the effect of this atmosphere is on human life and on little children, it would be difficult to overstate.

This town to all intents and purposes is owned by the company, which builds the houses, supplies light and heat, keeps up the streets, etc. The town government and company management are practically synonymous terms. No saloons are allowed in either of the two towns, although intoxicating drinks can be secured a few miles away. Drunkenness is the great curse of the Slavic miners of this region. The only doctors in the two towns are the three employed by the accident association of the company. One of these men acts also as health officer for the towns. The industrial medical service, which is the only kind available, is managed jointly by the miners through their unions and by the company. It serves the whole community as well as the miners themselves. The organization is known as the Employees' Death and Accident Association.

The object of this association is the establishment and management of a fund to be known as the E——

C—— Company Employees' Death and Accident Association. Out of this Fund, payments of definite amounts will be made to employees, contributing to the Fund, who under the regulations are entitled thereto in the event of their disablement by accident; also out of this Fund, provision will be made for the employment of doctors and assistants, for the furnishing of medical and surgical treatment of employees and their families, who, under the regulations, are entitled to receive same.*

The fund is administered by an executive committee composed of nine foremen, employees both inside and outside the mines, superintendents, the mine inspector, and the chief clerk of the company, who acts as secretary and treasurer of the association. "They investigate all claims for benefits, decide upon and direct all warrants that are to be drawn, and transact any other business — see that benefits are paid promptly and that the doctors render satisfactory service."

All employees are eligible to belong to the association, but membership is not compulsory. Non-employees living in the town can also belong, but pay $1.50 for a visit of the doctor. The dues are $1.25 a month for single men and $1.75 for married men, "collected semi-monthly from the payroll." The company donates $1,500 a year, and provides emergency hospitals and equipment in each of the two towns where their miners live, furnishing light and heat without charge. The head physician receives a salary of $350 a month and each of his two assistants $250 — salaries which are fixed by the executive committee.

Mine injuries are cared for by these doctors and all illness of members and their families. Medicines are free. For confinement cases and venereal diseases, there is an extra charge, that for the former not to exceed $5. When hospital care is required, the Mercy Hospital in Pittsburgh is used at the expense of the association. Sick benefit societies among the foreigners have the first examinations made by these doctors for $1 each. This money is turned over to the treasurer of the association.

There is an accident benefit attached to the association of $1 a day for six months, which is paid in addition to the compensation required by law. There are no sick benefits, however, except those connected with many fraternal organizations, such as the Moose and Eagles, and societies among the Poles and Lithuanians. Accident and death benefits of $300 are included, as the names of the organization would indicate. In case of natural death, a funeral benefit of $100 is allowed. The company employs a community nurse who works under the orders of the head physician of the association. The state pays the association for the services of its doctor each year to make physical examinations of the school children according to Pennsylvania law.

Since all the union leaders were away the day the company was visited, it was impossible to get their attitude toward this plan. The few employees whom we were able to interview spoke in highest terms in praise of it. The very fact that the unions are partners in its management tells its own tale of their consent. The doctor in charge of the work felt that it was "fine" for all concerned except for the physician. He voiced the old cry of the contract doctors that they were overburdened with unnecessary calls for minor ailments simply because their services were free. The one exception found to this general complaint was a physician in Michigan who was developing dispensary work as rapidly as possible. His desire was to get just as many people as he could to come to the dispensary for minor things, so that the really ill could be sorted out. His are the ideals of preventive medicine.

The Colorado Fuel and Iron Company of Pueblo has evolved a different system of industrial representation which affects health work in a most interesting way. It

* Regulations governing the E— C— Company Employees' Death and Accident Association, published by the company.

is generally spoken of as the Rockefeller Representation Plan, and is widely known. The underlying principle is representation of the humblest worker through the ballot in a committee form of organization. "Representation of employees in each camp shall be on the basis of one representative to every one hundred and fifty wage earners, but each camp, whatever its number of employees, shall be entitled to at least two representatives" (14).

Both in the steel mills of the company at Pueblo and in their chain of mines, the foreign-born workmen are present in great numbers, chiefly the Italians, Greeks, and Welsh. Thus many names such as Lucero, Blondo, Nacearatto, Morelli, Bevaqua, Ritz, Battiste, Lusik, and Keseric are to be found as signatories to the agreement made in 1915 between the company and the employees. These signatures mark the beginning of a new epoch for the immigrant employees of the company.

The details of the system cannot be gone into here, except as they relate to medical service and health work. Each of the five district conferences, in each of which there are present the president of the company or his spokesman and the elected representative of the employees, select four joint committees. "These 'joint committees' shall be available for consultation at any time throughout the year with the Advisory Board on Social and Industrial Betterment, the President, the President's Executive Assistant, or any officer of the Operating Department of the Company" (14, p. 9).

The committee on safety and accidents and the committee on sanitation, health, and housing are composed of six members each — three designated by the employees' representatives on the district conference, and three by the president of the company or his representative.

> The Joint Committee on Safety and Accidents may, of their own initiative, bring up for discussion at the Joint Conferences, or have referred to them for consideration and report to the President or other proper officer of the Company at any time throughout the year, any matter pertaining to the inspection of mines, the prevention of accidents, the safeguarding of machinery and dangerous working places, the use of explosives, fire protection, first aid, etc., etc.
>
> The Joint Committees on Sanitation, Health, and Housing may, of their own initiative, bring up for discussion at the Joint Conferences, or have referred to them for consultation and report to the President or other proper officer of the Company at any time throughout the year, any matter pertaining to health, hospitals, physicians, nurses, occupational diseases, tuberculosis, sanitation, water supply, sewerage system, garbage disposal, street cleaning, wash and locker rooms, housing, homes, rents, gardens, fencing, etc., etc. (14, p. 10).

In the selection of doctors to be employed by the company and employees in the future the workmen will have a deciding power. At the time the agreement was signed there were doctors already employed.

> In camps where arrangements for doctors and hospitals have already been made and are satisfactory, such arrangements shall continue. In making any new arrangement for a doctor, the employees' representatives in the camps concerned, the President's Executive Assistant, and the Chief Medical Officer shall select a doctor, and enter into an agreement with him which shall be signed by all four parties (14, p. 22).

It is hoped that in time this check will improve the grade of the medical service by weeding out the poorer doctors and that it will also give more satisfaction to the employees.

A brief description of the medical work now being carried on by the company will be necessary before discussing the relation of these committees to it. To support this activity of the company, all employees pay $1 a month. At Pueblo where the company has a large steel plant employing about 5,000 men, there is a 200-bed hospital owned by the company, which is excellently equipped with laboratories and

an X-ray outfit. The staff is paid and resident, with the exception of a few visiting men in the specialties who are paid for part time. Medical, surgical, and obstetrical services are the main functions of the hospital, but there are nose, throat, and eye departments, and also a dentist. This hospital service is free to all employees in Pueblo, and low rates are given to members of their immediate families. There is also a dispensary occupying a building by itself with two or three doctors in attendance. All applicants for work in the Pueblo plant are examined here, as well as men who have been absent over a pay day because of illness. The employees of the steel works are entitled to use this dispensary for any injury or disease. There is no medical care provided in the homes by the company in Pueblo itself.

In each of the thirty or more mining camps scattered through Colorado and Wyoming, a company doctor is provided who furnishes medical care, including medicines, for the employee and his dependents. Maternity services, care of venereal disease, and the results of fighting are excepted. A dentist travels from camp to camp, working chiefly with the children. It is hoped soon to employ another doctor who will act as school medical inspector for all the camps.

The joint committee on sanitation, health, and housing has a direct bearing on medical service, especially in the mining camps. The men who are selected to serve on it are paid $5.40 a day (the rate fixed by the representatives themselves) and expenses, regardless of their wages at the time of service. Automobiles are provided by the company for their transportation. The employees enjoy the opportunity to visit the different mines and regard the work as an honor. They make regular visits of inspection within their districts, spending two weeks out of every three months of service doing this. Such a system saves the company the employment of a large inspection force and stimulates the local boss, mine superintendent, and camp doctor to keep things in good condition. This naturally puts the men in charge of local conditions on their mettle to present a good appearance, and gives rise to healthy rivalry.

Because of the numbers of foreign born employed by the Colorado Fuel and Iron Company, the success of this system of representation is of interest. Officials of the company directly concerned with its trial state that it has been a wonderful factor in stimulating interest on the part of the workers. Not only do they notice conditions now, but they are given opportunities for self-expression. The result is an awakened consciousness of the part to be played by them in the promotion of better health for the miners and the securing of a more sanitary environment. The company officials also give testimony that the plan has value in giving opportunities for self-expression to all types of labor employed. Both from the financial viewpoint and in diminishing labor turnover and discontent, the system appears to them a paying proposition. When the polyglot character of the employees is considered, this success is still more significant.

Conclusions

Correspondence and conferences with industrial physicians, employment managers and others, have made it clear that relatively little attention has yet been given to the special medical and health problems presented to industry by the immigrant. A few individuals and establishments have begun to deal with certain of these problems but no very thoughtful and systematic work has yet been undertaken. This is true, despite the fact that the foreign born constitute a very large proportion of employees, particularly in many basic indus-

tries. Furthermore, the foreign born and their children are a majority of the entire population in many industrial communities, both large and small. In not a few of the middle-sized industrial towns and cities, the population is from 50 to 80 per cent. of comparatively recent immigrants and their children. The whole community life, in its health relationships as well as in other respects, is bound up with the problem of Americanization, and since in many of these smaller communities the only large and effective force is the industry itself, the responsibility of industry looms large. Its share in working out the medical and health problems of the community cannot be put aside, but it should act upon this responsibility in the right way.

It is also true that industrial medicine has been an industrial issue, not merely a matter with which the industrial physician and other technical workers have had to deal. In such major examples of economic welfare as the mining difficulties in Colorado in 1913 and 1914, the system of industrial medicine was very distinctly an issue. This is true today in many factories and mines, where the restiveness of employees under an ill-understood and little explained system of medical examinations or medical care is a stimulus to industrial unrest, and involves a diminution of the efficiency of the medical and health work for which the industry itself is paying out money.

The main conclusion from our survey of industrial medicine in relation to the immigrant is that industrial medicine, like other forms of medical and health work, ought to specialize in human relations as well as in medical relations. Where a large proportion of the employees are foreign born, knowledge and consideration of immigrant backgrounds and characteristics are essential if the medical service of the physicians and nurses is to give 100 per cent. value for its cost. The industrial medical men need to play in close relationship with departments that are growing up in many large industries, known as departments of industrial relations, etc., which are responsible for the development of satisfactory relations between employers and employees. Industry has so much more control over the employee while he is in the plant than the visiting nurse or dispensary social worker can usually acquire, that much larger results in curative and particularly in preventive medicine might be looked for if only industrial medicine were so organized as really to be understood by the employees, and therefore to enlist their hearty co-operation. The development of an industrial medical organization which will render this co-operation possible depends, of course, in large measure upon an industrial organization which, as a whole, establishes satisfactory relations between the employer and the employee. But industrial medicine can contribute toward this more effective industrial organization, or it can be a counterweight against it. Every effort to secure the participation of the employee in the support and the administration of industrial medicine should be made. The method of approach should be democratic and not paternalistic. The foreign-born employee offers special opportunities for the development of co-operation, because of the many societies to which such immigrants usually belong.

Some of the major questions with which industrial physicians and nurses are dealing are: the prevention of accidents; the prevention and, where necessary, the treatment of occupational diseases and of general disease; the maintenance and promotion of sanitation within the plant and of personal hygiene among the workers. Not a few establishments are also concerned with the food problem, since they maintain lunchrooms or restaurants. Now in every one of these six important problems, facing practically every department of industrial medicine in every industry,

successful work is greatly handicapped by the barriers of language and understanding between the immigrant and the native-born American. If the employers who are supporting industrial medical departments appreciated how much more efficient these departments would be made by proper knowledge of the technic of dealing with the foreign born, they would insist that their doctors and nurses acquire a modicum of this technic.

Industrial medicine must justify itself to industry on a business basis. The owners of industry, who pay for it, must feel that it pays them. The better the medical men they secure, the better it will pay, for one kind of industrial medicine that will never pay is the cheap kind. Really good physicians require adequate salaries. It is really good men who are more appreciative than second-rate men of the vital importance of human factors as an element in medical and business efficiency. It is the cheap man who conceives of and treats people cheaply. The keen, well-trained doctor is the one who will perceive and strive to deal with the special problems of the immigrant employee.

In this connection, it is well to note that the industrial physician should be directly responsible to one of the high officials of the plant, as the head of any major department would be. Only in that way will be realized the full value of the medical work as a practical contribution to business efficiency.

The larger problem of industrial medicine hinges upon the question, "How far shall industrial medicine go beyond the walls of the industrial plant itself?" Not a few industries have undertaken housing for employees, partly for sanitary and partly for other reasons. Medical care to employees in their homes, and sometimes to their families also, has been extended by some factories, in many mining communities and in some labor camps. To reach outside the industrial plant itself, visiting nurses have generally been the first resource. Sometimes the serious mistake has been made of using these nurses for other than their proper function. The employment of nurses as policewomen to hunt up absent workers and report on the reasons why they are away is a misuse of nursing, and reacts unfavorably both on the medical and health work and upon the general relations between employer and employee.

The entrance of industry into community medical care has been frequently observed to coincide with a low level of public health work in the same area. This is particularly true in regions where much of the community consists of foreign-born employees too recently immigrated to take much part in normal community activities. A marked contrast could be drawn between the conditions described on the iron and copper ranges in northern Minnesota and Michigan, where practically all the medical and health work is done by the industry for the community, and, on the other hand, the situation in Akron, Ohio. Several large industries in Akron have well-developed departments of industrial medicine, but largely through the efforts of one or more of these industries themselves the health work of the community under the city government has been advanced and assisted to a notable degree. Where industry has a far-sighted view instead of a short-range commercial one, industry will encourage community health work and not substitute industrial medicine for it.

The contract system as developed in the iron and copper ranges in Minnesota and Michigan is, in the main, a creature of the employer rather than of the community, and has the essential limitations of the manner of its creation. It is apparent that in a newly-opened country such a contract system will assure the employees and their families medical services which would usually be beyond their reach if the in-

dustry did not come forward. Physicians would be unlikely to move to a pioneer town unless guaranteed something by a responsible organization. The contract system of industrial medicine has also demonstrated its ability to provide hospital facilities which otherwise would often be lacking. It has doubtless been of assistance, when the medical service has been good, in promoting the health of employees, enhancing industrial efficiency, and keeping men on the job. But such a contract system shows almost everywhere the evils of any scheme of medicine which is on a commercial basis, and which has not developed with the understanding and co-operation of those who are the recipients of medical care.

The participation of the employees in support and in management, or at least in criticism, are hopeful signs, and further development in this direction is greatly to be desired. On the whole, except under pioneer conditions and for a temporary period, the development of industrial medical service outside of the industrial establishment itself must be regarded as an influence against Americanization in the larger sense, and against the more permanent interests of medical and health work of a community. If industrial organizations and, therefore, industrial medicine were wholly co-operative and democratic as between employer and employee, this might not be true. But under present conditions, it is to be hoped that medical and health resources will be developed and strengthened as much as possible out of community rather than out of industrial resources. Industry should do its share as a part of the community, but not more than its share. The initiative and self-dependence of immigrants and their families, and their understanding of the purposes and methods of medical and health work can be promoted only when they have responsibility and participation as citizens, rather than as passive recipients.

One of the leading industrial physicians of the country said in an interview: "Demands for improvements in medical service must come from the employees themselves. It is up to the industry to educate and guide by virtue of the trained minds which it can employ, but not to superimpose medical service upon the indifference of the employees."

"Workmen should be allowed to develop themselves," says another industrial physician of an important national corporation, "and industry should aid only in educational work."

Mr. Whiting Williams of Cleveland, in an article printed for circulation by the United States Department of Labor (15), says: "The price of maximum production is maximum personality for every human producer. Of this, the price is maximum outlet for that human producer's best and biggest feelings. That in turn can be bought only with right relationships and associations with all the persons of his world. Of that the price and the prize is democracy."

BIBLIOGRAPHY

1. Jenks and Lauck: The Immigration Problem. 1917 edition, p. 148.
2. Sixty-First Congress, Second Session, 1909. Senate Document, Vol. 78.
3. Population. Thirteenth Census of the United States, 1910, Vol. 1, 307.
4. Knoeppel, C. E.: Industrial Organization as It Affects Executives and Workers. Address before American Society of Mechanical Engineers, New York, Dec., 1918.
5. Selby, C. D.: Studies of the Medical and Surgical Care of Industrial Workers. U. S. Pub. Health Ser., Pub. Health Bull. No. 99, Washington, 1919.

6. Mock, H. E.: Industrial Medicine and Surgery — A Résumé of its Development and Scope. Jour. Indust. Hyg., 1919, **1**, 1.
7. Roberts, P.: The New Immigration, 1914, p. 134.
8. Leiserson, W. M.: Labor Camps in Wisconsin. Report of Industrial Commission of Wisconsin, 1913.
9. Price, G. M.: Industrial Medical and Dental Clinics in the Women's Garment Trades. Mod. Med., 1919, **1**, 49.
10. Harris, L. I.: The Labor Sanitation Conference: How Workers Have Organized a Movement for Industrial Sanitation. Month. Bull., N. Y. City Dept. Health, 1917, **7**, 61.
11. Geier, O. P.: The Human Potential in Industry. Address before American Society of Mechanical Engineers, May, 1917, p. 13.
12. Hayhurst, E. R.: Health of Ohio Coal Miners. Report of Ohio Health and Old Age Insurance Commission, Feb., 1919, Appendix D, p. 382.
13. Hayhurst, E. R.: Health of Illinois Coal Miners. Report of Health Insurance Commission of State of Illinois, May 1, 1919, pp. 396, 400.
14. Industrial Representation Plan, Colorado Fuel and Iron Company, p. 4.
15. Williams, W.: Human Relations in Industry. Leaflet printed by U. S. Dept. Labor, 1918.

THE ANTHRAX PROBLEM IN HORSEHAIR*

HENRY FIELD SMYTH, M.D., Dr. P.H.

Assistant Professor of Industrial Hygiene, School of Hygiene, University of Pennsylvania

THE question of the dangers of anthrax infection in industry from the handling of hides, wool, and hair is one of increasing importance in this country and the study of reports appearing from time to time in medical literature seems to indicate a growing menace in this respect, at least from the handling of hides and hair. Up to the present there seems to be little infected wool handled in the United States though the fact that there must be some danger from that source is shown in the report by Osborn (1) of 7 cases of anthrax in Massachusetts from 1917 to 1919 among wool handlers, 4 of them traceable to wool from Argentine, S. A., 1 to wool from Mexico or Argentine, 1 to wool from the United States, and 1 to wool of unknown origin. Five of the cases were in wool sorters and 2 in wool salesmen. (Crediting the cases to material from different sources is not quite clear in the article as it is stated that "in a few cases material from two or more countries had been handled" but just which cases these were is not mentioned.) The same report tabulates 89 cases in the leather industry, 5 from handling domestic leather and 9 in the horsehair industry or traceable thereto, 1 of these being a handler of domestic hair.

Rural Anthrax

That anthrax is well established in this country as a rural disease is shown by a study of the Census Bureau mortality statistics (2) from 1911–1918 which show a gradual increase in the yearly total of fatal cases of anthrax in rural districts. (See Table 1.) Table 2, a compilation of the census statistics with those given in the recent anthrax bulletin issued by the Bureau of Labor Statistics (3), shows that, in the ten years from 1910–1919, there occurred 102 deaths from anthrax in the rural districts of twenty-six states, an area extending from Maine to California and from Washington and Montana to Texas and Louisiana. This being the case, are we justified any longer in assuming that domestic hides and hair are not liable to infection, as is done by the Department of Agriculture in its regulations requiring disinfection of suspected materials? Many of the states, it is true, have laws requiring the prompt burning or burying of the unopened carcasses of stock dying of anthrax, but that this is not always done is shown by a study of the histories of many of the cases reported in the Bureau of Labor Statistics bulletin. At least seven of the cases reported were contracted from skinning dead animals and one farmer even "opened a cow to ascertain the cause of its death and found in its abdomen black spots which he dissected" (3, p. 78). In the *Journal of the American Medical Association* for August 7, 1920, King (4) reported two cases of anthrax in Illinois contracted from skinning a mule, the hide having been sold before the diagnosis was made. This shows the possibility of infected materials entering commerce in spite of laws to the contrary and without purposeful evasion of the law.

TABLE 1.—DEATHS FROM ANTHRAX IN THE RURAL PART OF THE REGISTRATION AREA, 1911–1918

Year	1911	1912	1913	1914	1915	1916	1917	1918
No. of Deaths..	5	7	13	5	15	10	19	22

* Received for publication Nov. 17, 1920.

Government Regulations

It is well known and has been frequently proved bacteriologically that anthrax-infected hides and hair are being continually imported from foreign countries in spite of

TABLE 2. — DEATHS FROM ANTHRAX, TRACEABLE TO RURAL OCCUPATION, IN THE UNITED STATES FROM 1910 TO 1919 *

Area	State	Deaths per State	Deaths per Area
New England	Maine	1	9
	Vermont	2	
	Massachusetts	1	
	Connecticut	5	
Mid Atlantic	New York	14	37
	New Jersey	4	
	Pennsylvania	17	
	Maryland	1	
	Virginia	1	
Southern	Louisiana	4	11
	North Carolina	3	
	South Carolina	2	
	Texas	2	
Central	Ohio	3	22
	Kentucky	6	
	Indiana	4	
	Kansas	2	
	Missouri	4	
	Wisconsin	1	
	Michigan	2	
North Western	Minnesota	2	5
	Montana	1	
	Washington	2	
Western	Colorado	5	18
	California	12	
	Utah	1	
Total	26 states	102	102

* Tabulated from reports in U. S. Census Bureau mortality statistics for 1918 and in Bulletin No. 267, U. S. Department of Labor, Bureau of Labor Statistics.

regulations of the Department of Agriculture intended to prevent this from happening. The Department of Agriculture (5) forbids importation of hides from countries where anthrax is known to be endemic, unless from a country maintaining efficient veterinary inspection, and accompanied by a consular or veterinary inspector's or other authorized official's certificate stating either that the materials have been "properly disinfected" or that they come from an area at the time free from anthrax. Osborn (1, p. 663) points out the impossibility of a consul or importer in all cases assuring himself of the fact of freedom from anthrax or of even being sure of the source of the bales offered for export. Wool and hair for importation must merely be "accompanied by an affidavit of the exporter . . . stating that all the wool or hair . . . came from animals free from anthrax" provided the consignee agrees to "disinfect" by exposure to 165° F. Apparently no consular or veterinary certificate is required (3, p. 151). If unaccompanied by such certificate, materials may be imported provided they are disinfected as soon as they are opened up at the factory where they are to be used. This offers no protection to the stevedore or freight handler and cases of anthrax among such men are not unusual, a number being reported in the articles referred to above. The Department of Agriculture provisions for disinfection of hair seem woefully inadequate to anyone who has done much laboratory work with anthrax spores. They require for horsehair "proper exposure to a temperature of not less than 200° F. for at least fifteen minutes, or in such manner as may be directed by the Chief of the Bureau of Animal Industry." The last saving clause does not apply, however, to hair "disinfected" before shipment to this country, and there is no provision in this ruling even for the opening up of the bales to afford penetration of the heat.

That the provisions of these rules do not adequately protect workers in this country is shown by the fact stated by Osborn (1, p. 658) that "this [consular] certificate was given in the majority of hide shipments

that apparently infected hide handlers in Massachusetts," and by the further facts that virulent anthrax has been cultivated from dressed hair imported from China, obtained in a hairdressing factory in Philadelphia, that the New York City health authorities * state that they have found anthrax in 75 per cent. of such dressed hair shipments from China, and that there were recently five deaths from anthrax in Chicago in a curled hair factory, presumably from handling Siberian hair (6). The numerous cases of facial anthrax traceable to infection from horsehair shaving brushes are further evidence of this fact, as many of these brushes have been made from Chinese hair.

Horsehair Dressing

In view of the above facts, and at the request of the hairdressers' union, the Pennsylvania State Department of Labor has conducted an investigation of the horsehair industry in Philadelphia, the center of hairdressing in this country. During this investigation, the author and a representative of the Division of Hygiene of the State Department of Labor visited twenty horsehair dressing shops, a haircloth weaving factory, a curled hair factory, a brush factory, and brush hair and bristle reclaiming shop. Most of the hairdressing shops are small plants with from two to six workers, the proprietors usually dressing hair themselves. The shops, with a few exceptions, are dirty and cluttered with horsehair, dust and litter being very much in evidence through the entire plant. Undressed hair is received in bundles or large bales and there is no provision for separate storage of washed and disinfected hair and suspected imported hair. Hair is collected from all over this country and from Canada, the bulk of the hair coming from Canada being so-called "live hair" or combings from live, presumably healthy horses, while practically all the hair from the United States is cut from carcasses or hides, much of the tail hair being received on the salted stumps. Some hair is washed at the point of collection and some is shipped unwashed. The proprietors claim that they wash all unwashed hair before dressing but workers stated that much is dressed unwashed. We ourselves have seen combings being handled without washing. The routine method of washing is to soak large lots of hair in wash-tubs or barrels overnight in soda solution made with hot water, but not kept hot, and in the morning to scrub the hair on a wash-board in hot soap or soapine solution, rinse, and dry either in a closed room heated by a small coal stove or on racks in the open in good weather. Hair received from infected areas, according to the present requirements of the Bureau of Animal Industry inspectors, must be so washed and then dried at 200° F. for twenty-four hours or more. This offers no protection to the washer or anyone who handles the unwashed hair.

There are three processes in hairdressing. The first process is "hackling" or combing out tangles, straw, etc., from the loose hair by throwing handfuls of hair over banks of stationary, pointed steel teeth and then pulling away all that will come. Frequent repetition of this process eliminates short hairs and arranges the rest in parallel bundles tapering to a point. These bundles are then "drawn" to size by being fixed between two sets of steel combs, the hairs of different lengths being drawn out by means of a razor blade held against the thumb. Small bundles of hair drawn to size are then "finished" by further combing, trimming and tying ready for shipment to the haircloth weavers or brush makers. Hackling is a dusty job when unwashed hair is handled, but dust is lessened somewhat

* Verbal communication from Dr. S. D. Hubbard, Division of Industrial Hygiene, Department of Health, New York City.

with all except white hair by the use of a little coal-oil on the hackling pins. The results of several dust determinations made with the Palmer dust sampler give an idea of the amount of dust produced in this

TABLE 3. — DUST DETERMINATIONS WITH PALMER DUST SAMPLER IN HAIRDRESSING ESTABLISHMENTS

Factory	Process	Hair	Amt. of Dust in ¼ Standard Unit Particles per Cubic Foot
L. H.	drawing	unwashed domestic	1,000,000
L. H.	hackling by open window	unwashed combings	1,000,000
W. K.	hackling	washed black domestic	617,000
S. Z.	hackling	bleached white hair	260,000
Average Count			719,250

process (Table 3). White hair is always clean and free from dust as it is routinely washed twice and bleached before dressing (see Table 3). No more dust samples were obtained as the majority of the workrooms were not equipped with electricity and so the Palmer apparatus could not be used.

Sampling and Testing for Anthrax

Samples of hair were collected in numbered sterile test-tubes and taken to the laboratory for bacteriological examination. There were collected 53 samples of undressed domestic hair; 9 samples of Canadian hair, and 20 of Canadian combings, all undressed; and 22 of undressed foreign hair — 4 from Australia, 6 from Argentine and 12 from Siberia. In all, 104 samples of undressed hair were examined and 13 samples of dressed hair from China. Of the undressed hair, 54 samples had not yet been washed and 50 had been washed. There was no record as to the washing of the Chinese hair but presumably it had been washed in some way before dressing. (See Table 4.)

The routine procedure of examination was as follows: Samples when brought to the laboratory were covered with sterile nutrient bouillon and incubated for twenty-four hours at 37° C. Then serial agar plates were poured from each sample and at the same time a subcutaneous inoculation of 1 c.c. or more of each sample was made into a guinea-pig. Plates were incubated twenty-four hours at 37° C. and then examined for anthrax-like colonies, using the

TABLE 4. — SAMPLES OF HAIR COLLECTED FROM TWENTY-FOUR SHOPS IN PHILADELPHIA HANDLING HORSEHAIR

Source of Hair	Kind of Hair	Stage of Manufacture *	Condition of Samples		
			No. Unwashed	No. Washed When Purchased	No. Washed in Shop Where Collected
U. S.	horsehair	undressed	13	21	15
U. S.	cow tails	"	2	..	2
Canada	horsehair	"	5	4	..
Canada	combings	"	18	..	2
Australia	horsehair	"	4	..	..
Argentine	"	"	4	..	2
Siberia	"	"	8	..	4
China	"	dressed	..	13	..
Total			54	38	25
Total U. S. and Canada			38	25	19
Total foreign			16	13	6

* The total number of samples examined was 104 undressed and 13 dressed.

technic suggested by W. A. Hagan of Ithaca (7). Any colonies showing typical curling with long, regular, parallel threads usually returning to the colony mass, with few free ends visible, no spores in twenty-

four hours, individual cells distinguishable with difficulty, and with no motility visible in any part of the colony, were transferred to agar and saved for further study. According to Hagan, such colonies are almost sure to be true anthrax, and anthrax colonies always have these characteristics. His statement is based on the study of plates from eighty-five suspected samples, giving seventy negatives and fifteen positives confirmed by animal inoculations. Any guinea-pigs dying after inoculation were autopsied and smears examined from the local lesions in the subcutaneous tissues, the heart blood, the spleen, and the kidneys. Agar slants were made from the heart blood and bouillon cultures from a bit of the spleen. When Gram-positive aërobic rods were isolated, even if no typical post-mortem lesions were found, subcultures in bouillon were inoculated in other guinea-pigs or in white mice, to determine whether or not the organisms were attenuated strains of anthrax. A similar plan was followed with any cultures from anthrax-like colonies on agar. From the entire series of tests but one typical virulent anthrax culture was isolated. It was passed through two guinea-pigs, producing typical lesions in each. This culture was obtained from one of the samples of Chinese hair. Three other samples of Chinese hair, obtained on the same day from the same shop, gave typical colonies on agar but failed to produce typical lesions in guinea-pigs. The same was true of one sample of domestic hair and one of the Canadian hair. Organisms were isolated from the heart blood of three other guinea-pigs, which, while not giving typical colonies or producing typical lesions, were present in such numbers in pure culture that they were injected into other pigs. Two of the three passed through the second pigs without producing typical lesions and failed to produce anthrax lesions in mice, so were not classed as anthrax.

When summed up, the results showed virulent anthrax in one sample from one of three shipments of Chinese hair and possibly avirulent anthrax in three other samples of the same shipment, and possibly avirulent anthrax in one sample of Canadian and one of domestic hair. The organisms designated above as possibly avirulent anthrax can only be so classed provided that Hagan's method of differentiation is reliable. Personally the author prefers to say that they were probably not true anthrax, and that while Hagan's method will probably correctly exclude all organisms not giving typical colonies, yet it is merely an excellent method of exclusion and not a certain means of positive diagnosis.

Disinfection Tests

Following the collection and culturing of samples of hair, a series of tests were carried out on the disinfection of horsehair impregnated with anthrax spores. For these tests forty-eight hour mixed bouillon cultures from the one virulent stain isolated, together with an anthrax organism previously isolated from a soak vat in a Philadelphia tannery, were used. Three samples of loosely matted undressed hair were placed in small Erlenmeyer flasks and sterilized in the autoclave for thirty minutes at 15 pounds pressure. Subsequent cultures showed a tremendous reduction in the number of colonies developing, but not complete sterility. (See Table 5–A.) A bundle of dressed hair, 6 inches long and 3 inches thick at the butt, was sterilized in the same way at the same time with a similar result, the samples for culture being pulled from the center of the bundle.

These autoclaved samples were then inoculated with anthrax — the flasks, by pouring 3 c.c. of forty-eight-hour anthrax bouillon into each and the bundle, by injecting 5 c.c. of the same bouillon into its

center by means of a long needled syringe plunged in at four different levels. The bundle was then resterilized in the autoclave for thirty minutes at 15 pounds pressure and thereafter no anthrax colonies

TABLE 5. — RESULTS OF DISINFECTION TESTS ON HORSEHAIR IMPREGNATED WITH ANTHRAX SPORES

A. Horsehair Subjected to Steam Sterilization

Material	Results of Treatment	
	Unsterilized	Autoclaved at 15 lbs. for 30 min.
Undressed loose hair	10 short hairs plated in agar gave innumerable anthrax colonies	10 hairs gave 6 colonies
Dressed hair bundle (6 in. long, 3 in. thick at butt)	4 hairs plated in agar gave innumerable colonies	4 hairs gave 42 colonies
Sterilized hair bundle inoculated through center with 5 c.c. anthrax broth	4 hairs gave innumerable colonies	no anthrax colonies in any of 12 plates containing 4 to 8 hairs

B. Horsehair Subjected to Dry Heat of 200° F. (93 + °C.)

Material	Time of Exposure to Heat					
	15 Min.	30 Min.	1 Hour	2 Hours	24 Hours	48 Hours
Sterile undressed hair infected with anthrax broth	4 hairs abundant growth	4 hairs abundant growth	4 hairs abundant growth	4 hairs abundant growth	10 hairs no growth	50 hairs no growth

C. Horsehair Subjected to Washing

Material		Results of Successive Steps of Treatment			
		Allowed to Stand in Hot 10% Na_2CO_3 Sol. for 18 Hours	Scrubbed in Hot Soap Sol. 10 min. and Rinsed in Hot Water †	Incubated in Drying Oven at 175°F. (79 + °C.)	
				24 Hours	48 Hours
Sterile undressed hair infected with anthrax broth	Sample 1	4 hairs in agar * numerous colonies	4 hairs in agar no anthrax	4 hairs no anthrax	50 hairs 1 anthrax colony
	Sample 2	4 hairs in agar 2 anthrax colonies	" "	" "	no anthrax " "
	Sample 3	4 hairs in agar no anthrax	" "	" "	" "

* Broth culture from agar plate of Sample 1 killed a guinea-pig in three days.
† Agar and broth cultures from soap solution after washing showed no anthrax.

were found in agar plates from twelve different samples, of four to eight hairs each, pulled from the center of the bundle. (See Table 5–A.)

From one of the inoculated flasks a loose bunch of hairs was fished out and placed in an open Petri dish in an electric drying oven for 48 hours at 200° F., samples being plated therefrom at intervals of 15 and 30 minutes, 1 hour, 2 hours and 24 hours, and after 48 hours the remainder of the sample was covered with agar. On incubation for twenty-four hours and subsequent observation for four days, the following results were obtained. (See Table 5–B.) Abundant anthrax developed after 15-minute, 30-minute and 1 and 2-hour exposures, but no

colonies of any type after 24 and 48-hour exposures to 200° F., showing the efficiency of the Department of Agriculture temperature requirements, provided the hair is loosely matted and the exposure continued for 24 hours, but, as was to be expected, the absolute inefficiency of 15-minute exposure.

The method of washing the hair, as described above, was tested with the balance of the hair in the inoculated flasks. The hair in each flask was covered with a hot 10 per cent. sodium carbonate solution. The flasks were then placed on a water-bath for eighteen hours (overnight), the solution in one of the flasks registering 55° C. in the afternoon and 68 °C. the next morning. Subcultures at this time showed anthrax in two of the three flasks, a broth culture from a colony obtained from one flask killing a guinea-pig in three days with typical lesions. The soda solution was then decanted and the hair covered with a strong hot solution of ivory soap, scrubbed vigorously for ten minutes with a glass rod and then rinsed with boiling water until the rinse water came away clear. Cultures from the decanted soap solution failed to develop anthrax. The rinsed hair was next transferred to open sterile Petri dishes and placed in the drying oven, which registered 175° F., and dried for forty-eight hours, cultures being made after twenty-four hours and forty-eight hours. No anthrax developed in any of the three twenty-four-hour cultures and but one colony in one mass forty-eight-hour culture. (See Table 5–C.) This shows that the method of soaking and washing in alkaline soap solution is fairly efficient provided the alkaline solution is kept hot, which is rarely done. As mentioned before, however, the method fails to protect the washer.

British Regulations

Industrial anthrax has been a serious problem in England for some years. The dressing of imported hair is a much larger industry there than with us and they have been endeavoring since 1905 to cope with the problem of rendering horsehair safe for the workers. The 1905 regulations, in addition to detailed precautions as to handling and storing of suspected materials, dust removal, hygiene of the factories and of the workers, require that wool or hair from certain suspicious districts shall be "opened either after steeping in water or over an efficient opening screen, with mechanical exhaust draft, in a room set apart for the purpose, in which no other work is carried on." There are, however, no provisions for sterilization given in these regulations. In the 1908 regulations provision for disinfection is made as follows:

> Suspected material must be disinfected either by (a) exposure to steam at a temperature not less than 212° F. for at least half an hour of material so loosened, spread out or exposed as to allow the steam to penetrate throughout, or (b) exposure of material to such disinfectant under such conditions of concentration and temperature of the disinfectant, and duration and manner of exposure of the material to it, and otherwise, as are certified to secure the destruction of anthrax spores in all parts of the horsehair subjected to the process.

"Certified" means certified by the director of a bacteriological laboratory recognized by a corporation in the United Kingdom having powers to grant diplomas, etc., thus placing the burden of proof on the laboratory desiring to certify. Under this ruling the most frequently employed means of disinfecting horsehair has been by the use of a proprietory preparation called "cyllin" with a rated phenol coefficient of 11 (Rideal-Walker). This was first certified (1908) for use on condition of immersion of the hair in a 10 per cent. solution for one hour at 60° F., the large bundles being opened out. Later the certification was changed to require a 2 per cent. solution for two hours at 98° F. or one hour at 130° F. (1912).

In a personal communication to the author Dr. T. M. Legge, Medical Inspector of Factories, writes as follows:

> Further experiments . . . have shown that anthrax spores can be cultivated and cause the death of guinea-pigs from anthrax in material treated on factory premises with cyllin. As, unfortunately, until the recent work on disinfection of wool [8] elaborated a completely satisfactory method of disinfection by (among other operations) the action of a 2 per cent. formaldehyde solution, no method of chemically destroying anthrax spores was known, the cyllin certificate has not been withdrawn. Recently this method has been found to be equally effective in the case of horsehair, and . . . a trial disinfecting station to treat material by the process named is in the course of erection at Liverpool.

The essential points of the method referred to are agitation for twenty minutes in an alkaline soap solution at 102°–110° F., squeezing through rollers, agitation for twenty minutes in 2–2½ per cent. formaldehyde solution at 102° F., squeezing through rollers, drying in a current of air at 160° F., and exposure for some days to dry air. The most valuable portion of the whole English method of handling the anthrax problem in wool and hair is the insistence on disinfection at the port of entry, if not sooner, in a government institution with adequate bacteriological facilities, of all materials imported from suspected countries, the small cost of disinfection being a charge against the product. This absolutely protects the worker and the consumer and seems to be an ideal plan.

Tests with cyllin had been planned as part of this investigation, but after the receipt of Dr. Legge's letter it was decided to publish the report before the cyllin had been received. A communication just received from the English company handling cyllin contains the following additional recommendations for its use.

> 1. Blood clots in the hair must be gotten rid of. This is done by passing the mixture through rollers and crushing the blood clots, etc.
>
> 2. Unless the most scrupulous care is taken in immersing the horsehair in the solution some portions of the hair are liable to remain unacted upon by the disinfectant owing to air locks, . . . place the hair in a vacuum cupboard, evacuate the air, and allow the solution to be sucked up from a reservoir beneath.

These precautions call for elaborate and expensive apparatus beyond the means of the small hairdressers in this country and emphasize the value of the English plan for central disinfecting stations.

Summary

The results of the entire investigation may be summed up as follows:

1. No anthrax was found in domestic hair, but circumstantial evidence is offered from vital statistics reports as to the possibility of anthrax-infected domestic hair occasionally reaching the hairdressers.

2. Virulent anthrax bacilli were isolated from a sample of dressed Chinese hair imported under consular certificate, and reports are cited of the same findings occurring frequently in other cities.

3. The absolute inefficiency of the Department of Agriculture rule for disinfection of hair, even when opened out freely, by exposure to 200° F. for fifteen minutes was demonstrated experimentally.

4. The effectiveness from the point of view of anthrax destruction of exposure of loose hair to 200° F. for 24 hours was demonstrated.

5. The effectiveness of washing hair in hot alkaline soap solution as recommended by the Bureau of Animal Industry inspectors in Philadelphia at present was shown but the fact noted that this washing does not protect the washer nor does it keep the stock rooms from becoming infected.

6. The absence of much dust in dressing washed hair was observed but considerable dust, liable to contain *B. coli* and other organisms from soil or animal sources, was seen in the dressing of unwashed hair.

7. General lack of cleanliness was observed, as well as the presence of evident fire risk in most of the establishments visited.

Recommendations

As a result of the above findings and of the absence of any protective rulings in this state the following recommendations or suggestions are offered:

1. Absolute insistence on the sterilization by steam under pressure for at least sixty minutes at 15 pounds pressure (above atmospheric pressure) of all imported dressed hair in bundles, the bundles to be stacked loosely and not closely piled in the autoclave and all air to be exhausted before obtaining pressure.

2. Absolute insistence on the sterilization of all imported undressed hair from countries where anthrax is prevalent by: (a) steam under 15 pounds pressure for at least two hours for baled hair with the same precautions as above; or (b) dry heat at 200° F. (controlled by the thermometer) for at least twenty-four hours for hair opened out loosely from the bale by forking and not by hand pulling, the opener to wear some type of mask or gauze protection over mouth and nostrils, and not to work in such unsterilized hair unless free from any form of open skin lesions; and the washer to wear overalls and cap, which should be sterilized by boiling or by steam after the washing of quarantined hair; or (c) disinfection by washing in hot alkaline soap solution followed by 2½ per cent. formaldehyde by the method used in England or by drying twenty-four hours at 200° F.; or (d) boiling dressed hair for at least three hours, as permitted in New York City (9).

3. Prohibition of the dressing of any unwashed hair whether foreign or domestic. The hair should be washed, as at present recommended by the Bureau of Animal Industry inspectors, in hot alkaline soap solution and dried at 200° F., unless so washed before receipt and accompanied by a certificate to that effect.

4. Separate storage for all unwashed hair apart from washed hair.

5. Disinfection of rooms in which unwashed imported hair from anthrax-infected countries has been stored as soon as the hair is removed for disinfection.

6. Lime washing or painting of all work or store rooms at least once a year.

7. Wet sweeping of all work or store rooms at least once a week, preferably daily.

8. Removal of all loose hair litter from benches and store rooms at the close of each day.

9. Informing workers, especially hair washers, of the danger of anthrax infection, the importance of washing well after handling unwashed hair and the importance of prompt attention to all skin wounds, however slight, or any localized skin lesion.

Preferable to those of the above suggestions which apply to foreign hair would be the adoption by the state, by several states or, better yet, by the federal authorities, of the English plan of establishing governmental disinfecting stations at one or more ports of entry, all imported hair and all wool from anthrax areas to be disinfected at such stations by standard methods before entering domestic commerce, the cost of disinfection to be charged against the infected or suspected materials. This latter plan would absolutely protect not only the hairdressers, but any hair handlers, from dray men and laborers to hair curlers, haircloth weavers, tailors and milliners, brush makers and brush users.

BIBLIOGRAPHY

1. Osborn, S. H.: Anthrax Problem in Massachusetts. Am. Jour. Pub. Health, 1920, **10**, 657.
2. Mortality Statistics, Bur. Census, 1918, p. 35.
3. Andrews, J. B.: Anthrax as an Occupational Disease. U. S. Bur. Labor Statis., Bull. No. 267, 1920, pp. 58–98.
4. King, R.: Anthrax from Removing Hide from Mule. Jour. Am. Med. Assn., 1920, **75**, 376.
5. Joint Order No. 2, U. S. Dept. Treasury and Dept. Agriculture, Jan., 1918.
6. Medical News: Anthrax in Shaving Brushes. Jour. Am. Med. Assn., **75**, 945.
7. Hagan, W. A.: The Diagnosis of Anthrax from Putrefying Animal Tissues. Jour. Bacteriol., 1920, **5**, 343.
8. Report of the Departmental Committee Appointed to Inquire as to Precautions for Preventing Danger of Anthrax in the Manipulation of Wool, Goat Hair, and Camel Hair. Cd. 9172, Vol. 2., H. M. Stationery Office, London, 1918, p. 30.
9. New Regulations to Prevent Anthrax. Weekly Bull., Dept. Health, N. Y. City, 1920, N. S., **9**, 201.

A STUDY OF PULMONARY SILICOSIS*

E. L. MIDDLETON, M.D. (Ed.), D.P.H.
Medical Officer to the Welsh National Memorial (Tuberculosis) Association

THE present paper represents an attempt to examine, from a clinical standpoint, a series of cases of pulmonary disease in which the patients were exposed to the inhalation of dust of high silica content in their occupations. All the cases were referred to the writer by private practitioners on evidence or suspicion of the presence of tuberculosis, and the chief interest of this study, therefore, is the mode of presentation of such cases as it occurs in general medical practice, and the possibility of deducing therefrom some method in the diagnosis and management of this type of disease. Better facilities for the earlier diagnosis of these difficult cases may become available in the future; a systematic scheme of industrial hygiene may be applied to the small bodies of workers who follow the more primitive of these industries in the secluded quarries and mines up and down the country; preventive measures may, by and by, place them on an equality with their fellows, who, being aggregated in large industries, claim more attention and receive help to pursue their work in safety. Such a desirable scheme of progress will probably sooner or later be realised. One group of the industries considered here — namely, the refractories industries — is already the subject of special regulations under the Factory and Workshop Act and of a scheme under the Workmen's Compensation (Silicosis) Act, 1918 — an act which is likely ere long to receive more extensive application.

The industries dealt with in the present contribution include: (1) manufacture of silica bricks, and silica flour milling, 18 cases; (2) scythe stone making, 6 cases; (3) lead mining, 16 cases; (4) quarrying, 6 cases; (5) stone-dressing, 11 cases.

* Received for publication Aug. 23, 1920.

Pathogenesis

The exciting cause of silicosis among the workers in the industries mentioned is finely divided dust containing a high percentage of free silica which is inhaled during various mining operations or trade processes. The conditions which lead to the development of the disease appear to depend on several factors among which special importance may be attached to (a) the amount of free or pure silica in the dust and the number and size of particles in the inspired air; (b) the condition of the atmosphere as regards gaseous impurities and moisture; (c) the physical condition of the worker; (d) accessory influences not directly connected with the employment.

Air Pollution by Dust. — Many ingenious devices have been invented for determining the amount of dust in a given volume of air and as a review of many of the methods was given in detail by Dr. Henry F. Smyth (1) in a recent number of this Journal it is not necessary to describe them now. Suffice it to say that the reviewer concludes that "no single method of our sampling for dust content as yet devised, is ideal." He suggests that "for complete studies and for fixing of permissible limits of dustiness, tests must permit of estimating weights and counts and determinations of the physical and chemical nature and size of dust particles. These tests are, at present, best and most easily made on samples collected with the Palmer apparatus, though the sugar filter samples treated according to Muir and Johnson's technic give as much information." A

criticism of the Palmer apparatus compared with an electrostatic method is given by Dr. J. Penteado Bill in another number of the Journal (2). The South African Phthisis Prevention Committee have investigated and described an instrument called the Kotzé konimeter, and they recommend it as "estimating speedily, and with a reasonable degree of accuracy, the quantity of dust in mine air . . . whilst the figures obtained are easily translated into general terms of effective and non-effective dust laying" (3).

The important points about silica-dust estimation are (1) that the particles can be counted and the number stated per cubic centimeter of air, and (2) that particles over 12 microns in diameter can be excluded as non-injurious. Gravimetric methods carry the serious objection of underestimating the dangerous properties of a dusty atmosphere; thus, a single particle of 100 microns diameter weighs the same as 125,000 particles of 2 microns diameter; the former on account of its size is non-injurious, while the latter are extremely injurious.

The amount of dust in the atmosphere of a workplace varies within wide limits according to the operations carried on and to such conditions as air currents and moisture. The South African committee, basing their standards on results attainable in practice, found that "to reduce the dust, as determined by the Kotzé konimeter, breathed by persons below 300 particles per cubic centimeter is not difficult in any operation. Anything above this is to be classed as unsatisfactory. Between 200 and 300 may be considered as fair, between 100 and 200 as good, and below 100 as very good" (4).* These conditions apply to the various operations in the gold-mining industry which include machine and hand-drilling, blasting and crushing a conglomerate of quartz pebbles in a siliceous matrix embedded in quartzite. The conditions of gold mining are very different from such processes as stone-dressing; but the committee also carried out some counts in the atmospheres of such industries for purposes of comparison, and found the states of dustiness similar. Thus, a monument mason working on moderately hard granite was found to be breathing air with 350 to 800 particles per cubic centimeter, of which 90 per cent. were fine. In two cases of stone-dressing by machines, the air had 1,000 particles in one, and in the other the dust was too thick to count, probably 2,000 or over. In the case of a man cutting sandstone, there were 200 particles, of which 85 per cent. were under 5 microns — yet the stone appeared to be damp.

The Essential Fineness of Dangerous Silica Dust. — The size of the silica particles is a consideration of the utmost importance in the causation and prevention of silicosis. On examining a section of silicotic lung, it is observed that the great majority of the particles included in the lung tissue are less than 2 microns in diameter and more than half the total are 1 micron or less in size, while few are above 3 microns. It follows from this, that the naked-eye appearance of the atmosphere of a workplace is no criterion of its safety, for the most dangerous particles are invisible under good conditions, and even much coarser contamination of air would be unrecognisable in the deficient light of mines, kilns, and sheds. Another important result follows from the fineness of the dangerous particles — namely, the difficulty of finding a respirator capable of arresting a safe percentage of the dust. Tests by the South African committee on respirators showed that they could stop about 50 per cent. of the particles entering the inlet, but all the particles which got through were about 1 micron in diameter and, therefore, dangerous. To increase the efficiency of the

* It must be mentioned, however, that there were several dissentients from the fixing of this standard as being too low to be readily attainable in practice.

respirator as a dust-trap is to increase the embarrassment to the breathing of the wearer. The dust which causes the lung changes in silicosis is, then, the very fine silica particles of less than 12 microns and averaging little more than 1 micron in size. But it is probable that the larger particles also play a part in the pathological processes. In densely polluted atmospheres, the nostrils of the workers become coated on the inside with fine irritating dust which produces catarrh of the mucous membrane and, in some cases, loss of the protective vibrissae of the anterior nares. The whole upper respiratory tract suffers in some degree and a chronic hyperemia or congestion of the nasal and pharyngeal mucous membrane is commonly found. The larger particles, which are liable to be caught in the air passages are the chief cause of these changes, while the very fine dust passes to the bronchioles and alveoli in the free mid-current of the inspired air.

Specific Qualities of Silica as a Disease Producer. — Recent researches and the observations of numerous investigators, indicate that the purity of the silica dust must be recognised as a factor of prime importance in the causation of silicosis. Unfortunately mortality statistics of silicosis are not available, but much attention has been given to the increase in the mortality from pulmonary tuberculosis in workers in materials containing free silica. As the evidence favors regarding phthisis as a frequent cause of death in persons suffering from silicosis, the inference is permissible that the statistics referred to can be used as evidence of the existence of silicosis.

Silica dust in its purest form is inhaled by the workers in the primitive industry of flint-knapping, and an investigation of the industry by Professor Collis (5) led him to regard the percentage of silica in any dust as directly associated with its power of inducing or predisposing to phthisis.

Experiments on guinea-pigs were carried out by Professor Beattie (6) in examining the effects of various dusts by inhalation. In the experiments, the animals were so confined as to inhale a large amount of dust over certain periods of time and afterwards the results were studied in the lungs postmortem. Fibrosis, with more or less obliteration of lung tissue, was found as the result of inhalation of many kinds of dust, such as tin-mine and lead-mine dust, pottery dust, slate-quarry dust, granite, carborundum, emery, cement and limestone dust. Thus fibrosis can be induced, in animal experiments at least, by the inhalation of dusts which in the industries are not associated with a high phthisis mortality — e. g., cement and limestone — as well as by the inhalation of dusts which are always associated with a high phthisis mortality — e. g., flint (pottery) and tin-mine dust.

The explanation of this apparent discrepancy may lie in the nature of the fibrosis and the reaction of the tissues to chemical properties possessed more pre-eminently by silica than by silicates or other minerals — a reaction which produces such an alteration in the tissues that the tubercle bacillus finds a suitable nidus for its growth. Further reference to this point will be made later, when the morbid anatomy is discussed.

The admixture of certain relatively inert dusts with silica dust is claimed to have a beneficial effect in stimulating the natural reaction of the bronchial secretions and cilia in ridding the lower air passages of the dangerous dust before it has become fixed in the tissues. A series of animal experiments was carried out at the suggestion of Dr. J. S. Haldane by Mr. A. Mavrogordato (7) with a view to "attempt some classification of dusts into those which predispose to phthisis or other serious lung troubles and those which do not." The results of this series of experiments led this

observer to make the following important deductions. The initial reaction is greater to "inert" dusts than to "dangerous" dusts and their elimination is more rapid and more complete. The admixture of inert dusts such as coal and shale with dangerous dusts stimulates the initial reaction, and brings about the elimination of more of the dangerous dust than would be eliminated in their absence. With the dangerous dusts the rate of elimination being slow, the dosage must be very small to avoid accumulation. The more free crystalline silica is from certain inert dusts, the less is the elimination and, therefore, the greater the accumulation in the lung tissues and the greater the fibrosis resulting.

The physical condition of the silica, apart from the size of the particles, may have an effect. Amorphous precipitated silica used in the series of experiments mentioned showed practically dust-free lung tissues, the inference being that this form of silica is soluble in body fluids, and its rapid removal obviates any change in the tissues themselves. Further experiments with this form of silica seem to be called for. It is possible that dense clouds, or longer exposures or both, would lead to accumulation, and then a positive or negative observation might be obtained of biochemical reaction in the tissues, comparable with what we assume occurs with the crystalline form and predisposes to attack by the tubercle bacillus.

Pathology

Gross Characters. — The appearance of the silicotic lung presents a departure from the normal in proportion to the severity of the disease present, the abnormal developments being along certain well-defined lines. The lung, though altered in consistency, may be normal in size and, in uncomplicated silicosis, may retain its form instead of collapsing, while in lungs in which tuberculosis has supervened and reached a chronic stage, contraction and loss of bulk may be marked, varying in degree and in situation.

Pleural adhesions are rarely absent. They may be massive and associated with greatly thickened pleura, or less dense and presenting on the surface of the lung a finely nodular appearance. Over most of the subpleural nodules there is a central zone of thickened pleura which is whitish, while the outer zone is a grayish-black.

The weight of the lung is always increased when silicosis is present. "When complications are absent it may be stated that the increase in weight corresponds to the stage of the disease" (8). Increase in weight may amount to twice the normal weight in advanced silicosis, when complications such as edema and pneumonia are included.

On section the lung may present some resistance, depending on the density of the older fibrotic areas; the cut surface presents a characteristic appearance of scattered nodules of a grayish-black color, more or less rounded in form and from 2 to 5 mm. in diameter, distributed throughout the lung. The nodules appear to vary in density and some show a central bronchiole or blood vessel, though others are uniformly dense. The intervening lung tissue shows a varying degree of emphysema. Dr. Watkins-Pitchford (8) describes three stages of change in the lungs of Rand miners with uncomplicated silicosis — the discrete, reticulated, and diffuse pigmentation — while the appearance of nodules called "fibrotic figures" indicates the presence of the tubercle bacillus in the silicotic lung.

Cavities of various sizes and forms may be present. Some of these bear the characters of chronic tuberculous cavities with vessels traversing them and with smooth walls. Such a cavity, $1\frac{3}{4}$ inch by 1 inch,

occurred in a ganister miner's lung described by Dr. F. W. Andrewes (9). A cavity of 2 inches in long diameter was described by Dr. Greenhow (10) in the lung of a millstone maker and stonemason who suffered from silicosis and who died of hemoptysis. The walls of the cavity in this latter case were "shreddy and black" and it contained a small quantity of dark bloody fluid. Fibrous nodules similar to those described in silica-stone workers were found in the diseased lung of a pearl-shell cutter examined by Dr. Greenhow (11), and it is interesting to note that the symptoms and course of the disease resembled those of the other pneumonoconioses (12). Professor Collis has pointed out to the writer that it was the sandstone wheels on which the pearl shell was worked which caused the disease in such cases, and that with wheels manufactured of abrasives which contain little or no free silica the trade has lost its excessive phthisis mortality.

Incineration Results. — If the lung be dried and incinerated the ash is found to contain silica. This fact was established by Dr. Greenhow (12) in 1865 in a case of grinder's asthma. In the cases reported on by Dr. F. W. Andrewes (13) in which the analyses were made by Dr. Scholberg, the dried lung of one case yielded a little over 3 per cent. of ash, with 24 per cent. and 36 per cent. of silica respectively in two different portions of the same lung, the higher percentage occurring in the less affected part — i. e., in parts not containing an abundance of new fibrous tissue. The other case yielded 6.6 per cent. of silica in dried lung. In a series of incineration analyses carried out by Dr. John McCrae and published by the South African Institute for Medical Research (14), the ash and silica content of the lungs of six Rand miners, who had suffered from silicosis, are compared with those of a Zulu, aged 30, who had never worked underground and whose lungs presented entirely normal appearances on postmortem examination. It was observed "that (1) the total weight of silica in the diseased lungs was much higher (from 2.8 to 9.6 gm.) than in the normal lung (0.55 gm.), and (2) the proportion of silica in the ash of the diseased lungs was much greater (from 29 to 48 per cent.) than in the normal lung (14.7 per cent.)."

Microscopic Structure. — Microscopic examination of a portion of affected lung shows particles of pigment, distributed according to the stage which the transformation of lung tissue has reached. With ordinary illumination, the particles are not readily seen, but with polarized light, they show up as minute brightly refracting particles; compared with the appearance by ordinary illumination the sites of clusters of particles can be traced as areas of yellowish pigment, which, on careful focussing, show a highly refractive appearance.

At the least affected parts, the pigment is found in minute granules within cells which resemble epithelial cells; the granules may be few and discrete or so numerous as to appear as a dense mass enlarging the cell and obscuring its structure. The cells containing the granules may be lying free in alveolar spaces, or more commonly they are in clumps between the walls of alveoli which are becoming disorganised by the processes of cell proliferation, invasion and condensation taking place at the periphery of a nodule. Granules may also be seen, however, lying free in the supporting connective tissue of the alveoli or in any of the interstices between fibers of organised new tissue. Following the distribution of the granules towards a nodule, it is observed that they are most abundant in proximity to the blood vessels which accompany the bronchioles. In such situations they occur in masses of a dark and dense appearance, which are grouped together at certain points in relation to the blood vessels; this grouping is so constant as to suggest a

structural cause, probably the site of the perivascular lymphatics, which are occluded by these masses of granule-laden cells.

On the edge of a nodule, where active proliferative changes are occurring with leucocytic infiltration, connective tissue proliferation, and fibrous tissue formation, granules are found scattered about, for the most part within cells, but sometimes free and in little streaks between young fibrous strands, as if granule-bearing cells had there been strangled and absorbed, leaving the mineral deposited to accentuate the irritation and bring about the formation of fully formed fibrous tissue which forms the basis of the nodule itself.

The nodule composed of dense fibrous tissue usually appears round in section, with roughly concentric arrangement of the fibers. This may be varied by the appearance of several centers around which the fibrous tissue is arranged, giving the effect of several smaller nodules within a single capsule which presents the advancing margin to the lung tissue at the periphery.

Each nodule presents a more or less similar structure. The densest fibrous tissue is near the center; surrounding this are strata of less dense and younger fibrous tissue, outside of which is the area of cellular activity described before. The center of the nodule commonly shows some change which is interesting. Here, the tissue is looser in texture, less definite in structure, and has the appearance of breaking down in a way which suggests what occurs in tumors and in fibroid nodules found in non-silicotic fibroid phthisis (15) (16).

Granules abound at this central zone, and it appears possible that this tissue with a deficient blood supply, the constant presence of an unimpressionable irritant, and an increasing pressure from new fibrous tissue around it, is undergoing necrosis, and may form a cavity, or retain this necrosed material *in situ*. It is in such situations that the Bacillus Tuberculosis is commonly found in advanced silicotic lungs, when typical tuberculous processes may not be evident in the lung. The presence of tuberculous infection is most usually accompanied by an unequal development of the silicosis in a lung or lobe, as the presence of tuberculosis tends to hasten the development of silicosis, especially in the earlier stages (17).

The bronchi show more or less complete catarrh of the ciliated epithelium. The mucous membrane generally shows chronic inflammatory changes, with dilatation of blood vessels, cellular infiltration and increase of interstitial tissue. The perivascular and peribronchial connective tissue is increased. The alveolar tissue shows congestion, dilatation of capillaries, increase of supporting connective tissue and catarrh of the epithelium. In the vicinity of the nodules, the lumina of the alveoli are, in parts, filled with cells derived from desquamated epithelium and from the invasion of leucocytes, giving the appearance of localised bronchopneumonia, while their walls are undergoing condensation and organisation by the infiltration of fibrous tissue from the nodules. At other parts the alveolar tissue shows emphysema.

Advance of the disease, as shown in parts more affected, takes the line of increase of connective tissue around the vessels and bronchi, with alteration of the loose tissue at first formed to denser fibrous tissue and gradual increase of the nodules at the expense of the surrounding lung tissue. The larger nodules are formed by the meeting and merging of smaller nodules through the obliteration of intervening areas of functioning lung.

The distribution of the mineral particles suggests that the perivascular lymphatics are earlier or more severely affected than the peribronchial. This distribution of foreign particles is seen also in sections of

non-silicotic lung, where carbon pigment is seen much more constantly in the perivascular than in the peribronchial lymphatics. This fact gives strength to the hypothesis that the blood vessels become obliterated before the corresponding bronchiole is rendered incapable of functioning, and that, indeed, the formation of fibrous nodules in the perivascular tissue may determine the fibrous obliteration of the bronchiole as a secondary stage of the process.

The obstruction of the blood vessels before the bronchioles may explain the absence of cyanosis in subjects of silicosis, who, in this series at least, present an unexpected absence of this symptom considering the degree of dyspnea which is usually the earliest and severest symptom (18). In contrast, however, cyanosis is typically present in cases of fibroid disease of the lung supervening on causes other than dust inhalation (19).

Symptoms

Variable Nature and Time of Onset. — A considerable period of time may elapse before symptoms show themselves even when an interval has been spent away from the dusty industry. Some authorities appear to regard a period of about ten years' exposure to the dust to be necessary before its effect can become manifest, but in the present series there is evidence that, in a much shorter time, sufficient dust can be inhaled to produce signs and symptoms which appear after a varying lapse of time. One of the writer's patients was exposed to silica dust under very bad conditions at the age of 15 and for a period of two years thereafter. Subsequently, he worked at non-dusty occupations and at 23 was examined because of a cough, but apparently nothing definite was found. At 28 he had influenza and slight pleurisy, and six weeks later he was examined by the writer and physical signs of early silicosis were found and noted. The symptoms all cleared up and, although he felt quite well and was unaware of any symptoms for two years, at the end of that period the physical signs were even more definite.

In another case in this series, the patient was exposed at the age of 20, for six weeks only, under very bad conditions. A history of cough and dyspnea dated from the time of exposure until he was seen by the writer three years later. Physical signs were found which could not be accounted for until subsequently when the history of exposure was obtained. Another patient, aged 42, showed very definite symptoms and physical signs two years after the commencement of a period of nine months' work in the silica-rock industries.

There are two points to remember, then, regarding the onset of symptoms: first, the period of exposure may have extended over only a few months, or even weeks in exceptional cases; and, second, the onset of symptoms may date from the time of exposure or from a variable time after the exposure has ceased.

In forty-nine cases of this series the period of exposure to silica dust in the industry under which each is classed, varied from 6 weeks in the case of the shortest, to 37 years in the longest, the average being 14.26 years. The shortest periods of exposure were found in the silica-stone workers' group, the longest in this group being 18 years, the average 3.75 years. The highest average duration of exposure was found among the stonemasons where the average was 22.3 years. The period of time which elapsed from the commencement of exposure until the admitted onset of symptoms, varied from 2 years in the case of a silica-rock worker to 48 years in the case of a lead miner, the average being 18.95 years.

No undue importance is attached to the influence of the particular industries here

considered, as many of the workers were employed at various times in other industries though, as far as possible, fallacies so arising have been excluded.

The Insidious Early Symptoms: Dyspnea. — The earliest symptom observed in an important proportion of the cases was dyspnea, although the commencement and increase of this symptom may be so insidious that it is not observed until some intercurrent catarrh produces an exacerbation. In the present series of fifty-seven cases, twenty-four gave dyspnea as the first symptom noticed. It was more frequently complained of by the older patients, as might be expected, the average age at the onset where this symptom predominated being 42.45 years, the youngest being 27 and the oldest 63.

It is doubtful, however, if the real duration and intensity of this symptom were correctly judged by the patients, as some had left the dusty industry for other occupations on account of their condition of health, before the onset of definite dyspnea would have been admitted. Thus, of the twenty-four cases in which dyspnea was the initial symptom, ten had left the industries for various reasons before the admitted onset, the average time which elapsed between their leaving the industry and the onset of the symptom being 10.6 years. In the cases which gave dyspnea as the first symptom noted, the earliest appearance was 2 years after exposure and the longest 30 years, the average being 20 years. Of these twenty-four cases, fifteen had worked in lead mines for variable periods and probably also in coal mines at intervals.

In cases in which dyspnea is the first symptom, it usually continues to be the worst throughout the course of the disease. It is present in some degree in every established case and, apart from complications, it can be relied upon as a guide to the degree of fibrosis present. It is commonly discovered by the patient for the first time when an intercurrent catarrh is present and the morning cough is troublesome. Inspiration is never complete and he has the feeling of "not getting to the bottom of his breath." As the chest wall becomes more fixed and the diaphragm is relied upon more and more for inspiration, anything which interferes with the action of the latter increases the dyspnea, such as exertion in a cramped position. It is remarkable the degree which objective dyspnea may reach, before the patient will own to discomfort on this account, chiefly because he avoids, more or less unwittingly, anything which will aggravate it.

Cough. — Cough occurs next in frequency as the initial symptom, and was given by thirteen patients in this series as the first observed. It was noticed first in five out of eleven stonemasons, in which group dyspnea was never given as the first symptom. In typical cases of older men, the cough is short and paroxysmal and occurs most at night and in the morning. In more advanced cases it is induced by any exertion which is associated with dyspnea. The common pleuritic attacks are accompanied by the short, irritative cough generally found with any form of pleurisy. The paroxysmal cough is generally followed by expectoration, which is commonly scanty, but may be absent or, on the other hand, copious and frothy or mucopurulent.

"Influenza" and "colds" were given as the onset in eight cases. This accords with the general experience in insidious disease; namely, that what is really an exacerbation due to an intercurrent illness, a secondary infection, or the supervention of a complication, is taken as the commencement of the illness (20), or, at least, affords a convenient place in the anamnesis to begin the record of symptoms. In some of the cases, such an onset proved to be the beginning of a more acute stage of the disease.

Other initial symptoms given were: pain in the chest, 5; weakness, 4; indigestion, rheumatism and pneumonia, 1 each.

Hemoptysis. — Hemoptysis was never the first symptom but it occurred in sixteen of the fifty-seven cases during the course of the illness, and varied in amount from definite coloration of the sputum to quantities of a pint or more. In two cases the hemoptysis was so severe as to prove fatal; in two others it was severe (over ½ pint); in seven it was slight (under 4 ounces); and in the others, streaks and coloration of the sputum. In both of the fatal cases, tubercle bacilli were found in the sputum. In one of the severe non-fatal cases, the hemorrhage occurred in a man, aged 30, two years after an attack of pleurisy. This patient, a stonemason, died at the age of 45 from spontaneous pneumothorax. In the absence of a sputum report, the history indicates that this case was tuberculous. In five of the seven cases of slight hemoptysis, tubercle bacilli were found, and also in one of the four cases with colored or streaked sputum. The other severe non-fatal case was a florid alcoholic of 53 with very scanty sputum and extensive pulmonary fibrosis. Generally speaking, then, hemoptysis may be associated with the presence of a tuberculous process.

Other Symptoms. — Pleuritic pains are common during the course of the illness, and may appear early; fluid effusions have been met with in tuberculous forms; and spontaneous pneumothorax occurred in two cases. Pains of joints and muscles were complained of by some patients, more especially of the lead-miner series.

Of other symptoms, night sweats occurred in 27; weakness in 47; and wasting in 45. With regard to the last three symptoms, they were found in most of the advanced cases, but night sweats did not occur at all in a few. The causation of these symptoms is probably related to the economic position in which the incapacitated worker finds himself after months or years of invalidism.

Physical Signs

In the last section the onset of symptoms, as stated by the patient, was shown to be unreliable; it may be delayed, and is frequently due to an exacerbation from the occurrence of a secondary catarrh or the supervention of tuberculosis. The first indications of the departure from a physiologically sound lung condition are demonstrated by physical signs. This seems to be logical when it is remembered that symptoms depend on the failure of a system, while physical signs may be capable of detecting a fault in a portion of the organ before the wide physiological margin has been overstepped, and symptoms originated.

Silicosis is a disease only according to the degree in which it departs from the accepted normal of adult life, and there is danger, therefore, of classing as diseased, what is relatively little abnormal for the age and constitution of a particular individual. Only by collecting information regarding the slightly affected cases can knowledge be arrived at as to what degree of divergence from normal is to be regarded as requiring precautionary measures, such as removal from an industry, and what may safely be allowed to pass. The danger and difficulty, of course, lie in the time which it takes for the inhaled dust to produce the pathological changes in the lung to which the physical signs and symptoms are due. The presumption is, that if symptoms are already observed, or even physical signs which can be recognised as being due to early silicosis, the person giving such evidence should be excluded from the industries, because the process does not cease when inhalation of dust ceases, but the distortion of the lung goes on in proportion to the amount of dust inhaled and the factors

governing the pathological processes which ensue.

Early Diagnosis. — A diagnosis should be made as soon as possible. Routine examinations in dusty industries are, therefore, greatly to be desired. The physical signs, however slight, at each examination should be charted, and variations in later findings carefully noted and their value assessed.

On physical examination the general aspect of the patient conveys very little unless the disease is advanced. There is, however, none of the apparent robustness or flush of health in this series that was noted by Oliver in the gold miners of South Africa (21). The conformation of the chest may present change. This usually takes the form of flattening anteriorly, with more or less round-shouldered deformity. The barrel-shaped chest of the emphysematous type is not seen in most cases. The infraclavicular fossae and the intercostal spaces tend to be hollowed, and the extraordinary muscles of respiration are active more or less, depending on the development of fibrosis. The skin is generally pale and subcutaneous venules about the front of the chest are frequently noted. Diffuse pulsation may be seen over the precordia. The musculature has usually lost much in bulk and consistence, and the general nutrition is practically always below normal.

The expansion of the chest is always diminished, usually equally on the two sides, but not infrequently more on one side than the other. Resonance is always diminished, especially about the apices and low down in the axillary areas, but the note may be variable, and over the anterior of the chest hyperresonance may be noted. Areas of dullness may be found irregularly distributed and especially associated with thickened pleura about the bases. The breath sounds are frequently diminished in intensity in various areas, especially at the bases posteriorly; they are typically of a high-pitched and "whiffing" quality in more advanced cases, and over some areas are bronchovesicular. Deep or distant bronchial breath sounds may be heard frequently in the interscapular regions, and, in tuberculous cases, bronchial or amphoric breath sounds can be heard.

Adventitious sounds may be absent even when extensive alteration of the respiratory murmur is present, but, apart from the modification of the breath sound which is the most typical and the earliest of all the signs, the earliest added sounds are fine sibilant rhonchi, which may have their greatest intensity in any area.

Crepitations at the lung margins are commonly heard and are not of much significance, but when indicating moisture, they are often associated with the presence of tuberculosis, but not necessarily so, as secondary catarrhal conditions and post-pneumonia consolidations frequently present such signs. In early cases, special importance should be attached to slight alterations in the quality of the breath sounds associated with diminution of intensity, and the presence of sparse adventitious sounds, especially rhonchi, provided that such signs are persistent in character, though they may vary to some extent in apparent position.

The Early Physical Signs. — Abnormalities of the upper air passages of a congenital or acquired kind should be excluded, especially such conditions as nasal obstruction and chronic catarrh; otherwise, the physical signs may be misleading. The commonest site for the early signs to be found is, in the writer's experience, in the right mammary region. Above the fourth rib the breath sounds may be of a harsh character and rather puerile in quality; below this, and sometimes sharply delimited, the characteristic fine vesicular murmur is found of a soft "whiffing" quality and associated with diminished vocal resonance. Later this extends into the axillary region, and

still later can be found at the corresponding site on the left side. The early fine sibilant rhonchi which appear can be heard equally well from the mammary area, or posteriorly about the angle of the scapula. The respiratory murmur over the other areas may be normal or, more usually, slightly harsh and with slightly prolonged expiration.

With the occurrence of tuberculosis in a silicotic lung, the physical signs tend more and more to resemble ordinary chronic phthisis as the tuberculous process extends. For a time the character may be more fibroid in type, but at length localised foci of breaking down occur and the character of the physical signs and the course of the symptoms change accordingly.

Radiography. — Radiography provides a valuable addition to the ordinary means of diagnosing silicosis, and, in addition, can give useful help in detecting the presence of tuberculous foci and other complications.

In early uncomplicated cases of silicosis the hilus shadows are seen to be increased, and the branching shadows which radiate from them appear thicker than normal. The linear shadow of the interlobar fissure, referred to in one of the cases cited later, is met with. Finer branching shadows may be seen in the peripheral parts. With more advanced silicosis the branching shadows increase in number and density with a tendency to run together, so forming a general mottling. In later stages, rounded dense nodules are scattered more or less uniformly throughout, giving the so-called "snow-storm" appearance referred to by South African observers (22).

The presence of tuberculosis is denoted by greater density and increase of hilus shadows; sometimes evidence of calcification of bronchial glands may be seen with increase of the shadows thrown by the larger bronchial trunks. Localised foci in the lungs show as more or less dense shadows with irregular outline in spreading disease or sharply defined in localised consolidations. As with clinical signs, increasing tuberculous disease tends to obscure the characteristic radiographic appearances of silicosis.

Typical Instances

The description of *an early case* will serve to illustrate the physical signs of this stage.

Case 1. — H. P., a man aged 39, giving a satisfactory personal history, was employed five years previous to examination at a silica-brick works and was exposed to dust more or less for four years, when he was advised to leave off this work. Just before the end of his third year he observed dyspnea, and six months later a cough at night. He was examined by the writer eight months after he gave up the work.

The general condition was fairly good and the musculature satisfactory. Nasal vibrissae were very good; the fauces slightly red. The radial artery was thick for the age of the patient; the first cardiac sound was impure; the apex beat one-half inch internal to the nipple line in the fifth space.

The chest appeared symmetrical, but expansion was diminished — expiration 31 inches, inspiration 32 inches. Resonance to percussion was diminished on both sides posteriorly in the interscapular regions, especially on the left. Over the front of the right side of the chest, the respiratory murmur was weak generally and, on the right side posteriorly, there was diminished air entry from the spine of the scapula to the base margin. On the left side, in front, over the third and fourth spaces, breath sounds were harsh and expiration was prolonged, and towards the axilla base the sounds had a finer harsh quality. Posteriorly in the infrascapular region, the breath sounds were very harsh and expiration was prolonged in greater degree; just above this area, the resonance was definitely diminished.

No adventitious sounds were heard then, but the medical officer had noted "bronchitic" signs over both lungs nine months before. The radiogram showed an increase of the hilus shadows of both sides, with a linear extension outwards and downwards on the right, corresponding to the interlobar fissure and associated with some mottling towards the mesial end and in the region of the scapular angle; the hilus shadow was also increased upwards. A somewhat conspicuous shadow on the left side just above the heart shadow indicated what was probably an early tuberculous consolidation.

An intermediate case will now be described.

Case 2. — I. W., aged 43, a bricklayer, was formerly employed in house building, but for the ten years previous to examination had been employed at a steel works, building and repairing the brickwork of furnaces. Several kinds of bricks were used, including fire-clay, ganister, and silica bricks, and much dust was produced from chipping and handling the bricks in building, and in pulling down the furnaces for repair when hot.

Dyspnea was the worst symptom and had been noticed for four or five years; pain in the chest on coughing, for the same time. The cough was paroxysmal and chiefly at night; the sputum was scanty, streaks of blood had been noticed but never in quantity. No night sweats had occurred and no loss of weight. The patient was still at work at the time of examination. The general condition was poor, the muscles flabby and the patient looked thin and pale.

Resonance was diminished over both apices posteriorly. In front, over the upper part of both sides, from the clavicle to the fourth rib, the breath sounds were of a harsh character; below this area anteriorly, the breath sounds were diminished, and of a fine bronchial quality. Posteriorly, the upper area of both sides showed diminished air entry with breath sounds of a fine harsh character. At the left base near the angle of the scapula a few rhonchi were heard. No tubercle bacilli were found in the sputum. These physical signs are very typical.

An advanced case may be briefly described.

Case 3. — T. M., aged 53, was employed as a farm laborer until nineteen years previous to examination; for fourteen years thereafter, he was employed as engine driver at a stone quarry, and for four years subsequently he worked at silica-rock milling. For the last year he had been at a chemical works. At the time of examination dyspnea, which was the worst symptom, had been noticed for ten months, cough for three months. His sputum was white and frothy. Pain on both sides of the chest had been complained of in the past but was better. He had lost about 20 pounds in weight during the last year and weighed only 6 stone 5 pounds at the time of examination. He had night sweats a year previously but not since.

The general condition and the musculature of this patient were poor, and he looked senile and emaciated. The chest was thin and shrunken and expansion was scarcely perceptible; the neck muscles only appeared to move with inspiration. Respirations were short and hurried — 40 per minute at rest. The chest examination revealed evidence of diffuse bilateral pulmonary fibrosis. At the right base loud coarse friction sounds and some crepitations were heard. At the left base similar friction sounds and crepitations were heard in less degree. A loud systolic murmur was heard at the mitral area and propagated widely.

In none of these three cases were there characteristic symptoms or physical signs pointing to the onset of tuberculosis, nor were tubercle bacilli found in the sputum. In all, the distribution was bilateral, almost symmetrical and grouped about the central zones of the lungs, with a tendency to involve the bases rather than the apices.

An early case with the addition of active tuberculosis will now be described.

Case 4. — L. R., aged 21, was employed in a silica brickworks for three years, until about two years previous to examination when he went to work in a silica-rock quarry, at first on the rock and later on a rope-winding machine. He had had a dry cough for some years; rather severe dyspnea on exertion and indigestion for the last two years. A week before examination he had slight hemoptysis.

On examination he had cough, scanty sputum and pain at the left base; good appetite; no night sweats. The general condition and muscular development were good, but there was evidence of slight anemia. The chest examination showed, over the right upper lobe, a diminished resonance, diminished air entry, and crepitations after a cough. At the right apex posteriorly, the breath sounds were bronchovesicular. The pectoral muscles on the right side showed myotatic irritability. No tubercle bacilli were found in the sputum at this time even by the antiformin method, but they were found some weeks later. This case shows a characteristic history up to the onset of the tuberculous disease. The physical signs were almost entirely confined to the lung affected by tuberculosis.

An advanced case with tuberculosis is typified in the following:

Case 5. — W. J. W., aged 38, had been employed in a silica brickworks for twenty-one years. He had always been engaged in setting the bricks in the kilns, at first carrying-in, and then "setting" the bricks, an occupation associated with a dusty and often hot atmosphere in a confined place. He had been working regularly up to the time of examination, but felt that he must give it up. Five years

previous to examination he had pleurisy and had noticed dyspnea on walking up hills since; he had pneumonia eighteen months ago. At the time of examination he complained of cough and frothy sputum every morning with dyspnea, which improved as the day went on. He was worse on Monday mornings, and always worse in winter. Pains in the right side of the chest were fairly frequent. Tubercle bacilli were present in the sputum.

The general condition of the patient was poor; he was pale, and the muscles showed poor tone. The chest expansion was $34\frac{3}{4}$ inches to 36 inches. The radial artery was thickened. The nasal vibrissae were scanty and broken off short; the mucous membrane of the nostrils was hyperemic. Percussion showed dullness over the upper part of the right lung front and back, and diminished resonance over the left apex front and back, and over the right base. Air entry was diminished over the whole of the right base posteriorly and over the mammary and axillary regions; also over the whole left posteriorly. Over the upper half of the right lung, bronchial breath sounds and numerous crepitations were heard: over the upper half of the left side the breath sounds were harsh and a few crepitations and sibilant rhonchi were heard. Over the lower part of the left lung in front and in the axilla, the air entry was much diminished and the breath sounds were of a fine "whiffing" quality. The superficial cardiac dullness was diminished in extent; over the precordia the impulse was diminished. At the mitral area a soft diastolic *bruit* was heard; at the aortic, a short systolic and a long diastolic; at the tricuspid, a short systolic and a much prolonged diastolic; at the pulmonary, a short diastolic *bruit* and a reduplicated second sound.

The radiogram showed diffuse mottling over both sides with extensive dark areas corresponding with the upper half of the right lung, and a less extensive dark area occuping the site of the left subapex.

This excellent workman was most amenable to any advice offered him, and was anxious to adopt any measures for the amelioration of his condition and to act as an example to his fellow workers. When seen first he was wearing a perforated zinc respirator fitting over the mouth and leaving the nostrils free. On advice he assumed the Keeling-Walker respirator. But the time for prophylaxis was past for him, and, for want of timely advice, he was an old man with a bad outlook at 38.

TABLE 1. — CASES OF TUBERCULOSIS FOLLOWING EMPLOYMENT IN DUSTY OCCUPATIONS

Occupation	No. of Cases	Employment in Industry in Years			Average Age at Onset in Years	Average Time in Industry before Onset in Years	Initial Symptom		Other Symptoms				T. B. in Sputum	Family History of Tuberculosis	Fatal Cases	Average Age at Death in Years	Average Term of Invalidism in Years	Average Duration of Symptoms
		Shortest	Longest	Average			Dyspnea	Cough	Hemoptysis	Night Sweats	Weakness	Wasting						
Silica-stone workers	18	6 wks.	18	3.75	37.0	13.2	9	3	7	5	14	13	5	5(1)*	8	39.5	1.83	3.8
Scythestone workers	6	2.5	33	21.0	38.66	17.2	2	1	3	2	5	4	2	3(2)	4	48.75	1.75	3.5
Quarrymen	6	..	..	..	41.83	..	2	..	2	3	4	5	6	2(2)	5	44.2	2.08	2.5
Lead miners	16	4	37	18.75	44.41	23.7	11	4	3	9	15	13	4	5(4)	12	48.58	1.58	3.75
Stonemasons	11	15	32	22.3	40.25	22.4	..	5	1	8	9	10	4	4	6	46.16	11.33 mos.	6.25
All occupations	57	..	..	14.259	40.41	18.95	24	13	16	27	47	45	21	19	35	45.5	19.45 mos.	4.0

* Numbers in parenthesis are additional cases with doubtful family histories.

Prognosis

Silicosis. — With a fibrosis sufficiently extensive to affect more than a minimum amount of air tissue, a progressive course of symptoms is to be looked for. The amount of involvement necessary before definite disease can be considered permanent appears to vary with the individual. Every individual commences life with lungs free from silica, but as age advances an increas-

ing accumulation occurs from the inhalation of dusts to which he is fortuitously exposed, until, in adult life, silica forms an appreciable percentage of the lung ash. According to the exposure, on the one hand, and the efficiency of the natural defensive mechanism, on the other, the lungs become "aged" by the accumulation of dust and the resulting fibrosis. The term "silicosis," therefore, is relative, and implies that the sufferer has exceeded the limits of average balance between inhalation and elimination, with the result that a deleterious accumulation has accrued to his disadvantage.

The course of the disease, then, must vary with the factors involved. In some cases where the exposure has been very unfavorable — that is, when dense clouds of the finest particles have been inhaled, possibly in oppressive atmospheres or associated with arduous exertion so that mouth breathing has been the rule — symptoms may be found early and are then due to the catarrhal reaction. This reaction, in the case of pure silica dust, is never sufficient to ensure elimination of such degree as to prevent accumulation, for the reaction, from experimental evidence, appears to be less than in the case of "inert" dusts and, from clinical observation, shows a greater tendency to resist elimination. Such exposures, therefore, are associated with relatively acute onset and progressive symptoms. Cases of this sort are found in silica-crushing processes. Less severe exposures, such as in quarrying, are associated with later onset and more chronic course, while lead mining may lead to a much delayed onset. If the condition is recognised at a very early stage and the patient is removed immediately and permanently from the danger of dust inhalation, the amount of change produced in the lung may be less than is required to produce any degree of conscious disability. The first case cited under the paragraph "Symptoms" is an instance of the limitation of the disease process by timely removal from risk. It will remain to be seen how far the process of fibrosis in such cases can go after the source of irritation has ceased. So long as the condition remains one of uncomplicated silicosis, the progress is virtually dependent on the increase of dyspnea. Intercurrent catarrhs, which appear to be frequent, increase the dyspnea, and definite chronic bronchitis may be established, rendering the patient specially liable to exacerbations of an inflammatory character. Thus, in the case of Hugh Miller (23), who as a stonemason had been exposed to the dust of a very dangerous sandstone, "the stonemason's disease — the presence of particles of stone in the lungs — augmented the torturing irritation of repeated inflammatory attacks in this most sensitive organ" in 1855. A year later his wife, after advising him to consult his doctor, Professor Miller, tried to dissuade him from going out on account of the weather which was bitterly cold with drizzling rain: "You know that if you go out, you will bring on another inflammatory attack in your chest, and then I shall have done more harm than good."

From the onset of symptoms until death, the period of time which can be called the illness, varies widely. The reservation regarding the actual onset and the admitted onset must be kept in mind, as the latter only is available to the clinician. Longest in the stonemason series, the average duration of symptoms in 6 fatal cases among these workers was $6\frac{1}{4}$ years; in 12 lead miners, $3\frac{3}{4}$ years; in 8 silica workers, $3\frac{3}{4}$ years; in 4 scythestone makers, $3\frac{1}{2}$ years; in 5 quarrymen, $2\frac{1}{2}$ years.

From the admitted onset of symptoms in cases which end fatally, the illness may last, in this type of case, with more or less gradual increase of symptoms, from one year or less to seventeen years. In uncomplicated cases, death may result from pneumonia or influenza or from general

failure of the heart following on the respiratory embarrassment and loss of strength.

Silicosis with Tuberculosis. — The most important variation in the course of the disease is the occurrence of tuberculosis. While there is evidence that tuberculosis may co-exist with silicosis without producing any apparent alteration in the course of the disease, in the majority of instances, the development of tuberculosis is along a different line and produces definite evidences of its presence. In the earliest cases of silicosis, and especially in young subjects, the disease when first seen may be indistinguishable from ordinary tuberculous phthisis. The superadded disease has produced symptoms before the antecedent silicosis has developed sufficiently to demand medical attention — hence it is missed.

The influence of the two conditions on each other when existing together may, however, give some information, for, as has been mentioned before, the silicotic process is hastened in the presence of tuberculosis, and the changes due to it are unevenly distributed throughout the lung or lobe. Hence an access of activity in the course of silicosis with a development towards a tuberculous type gives an indication which is obvious enough. More and more such a case approaches the ordinary tuberculous disease as it advances, with the wasting, lassitude, pyrexia, night sweats and increase of cough and expectoration found in the common ulcerative chronic tuberculosis.

The occurrence of tuberculosis has the effect of carrying the disease to a fatal issue more rapidly than when this complication is absent. In fifteen cases in which tubercle bacilli were found in the sputum, the average duration from the onset of admitted symptoms was 3.17 years; in twenty cases in which tubercle bacilli were not found, the average duration was 4.62 years. The difference as stated is less than it should be as several cases of shortest duration in the latter group were certainly tuberculous, though no opportunity was obtained for sputum examination.

Dr. Brownlee (24) of the Medical Research Committee has made a recent statistical study of the epidemiology of phthisis, and he finds that the disease incidence presents three age groups, corresponding to early, middle and advanced life, the middle group being chiefly affected by environment. This middle-age group is that of the "accidentally phthisical," who in all probability would have got through life without succumbing, had it not been for the unfortunate conjunction of an injurious environment with a limited personal resistance, which gave way under the extra load.

Although it would be unsafe to attach much importance to any such grouping in the present instance, especially as the term "phthisis" in mortality statistics is made to bear so many interpretations, it is nevertheless worth noting that a majority of the early fatal cases of silicosis are complicated by a tuberculous process of a type which comes near to ordinary adolescent pulmonary tuberculosis in symptoms, course and physical signs. On the other hand, the picture of pulmonary tuberculosis in the middle-aged silicotic bears a strong resemblance, in the same particulars, to the industrial disease, pure and simple, in which no evidence of tuberculosis is found.

Dr. E. L. Collis (25) shows from statistics collected from the annual health report of Sheffield that, among ganister workers, who die at the average age of 39 to 40, "phthisis" accounts for from 75 to 84 per cent. of all deaths occurring between the ages of 25 and 55. Collis also gives the data from another official source to show that among sandstone dressers the mortality from "phthisis" is about half that of ganister workers of the same age, and that the average age at death is nine years greater.

The development of tuberculosis in the subjects of silicosis was believed to be determined by predisposition, and this opinion was expressed by Dr. Greenhow. There appears to be a relationship between the development of tuberculosis and a family history of this disease.

It might, of course, be argued that cases of pulmonary tuberculosis occurring in young persons exposed to silica dust are ordinary cases of that disease without reference to the industrial environment, and in some cases this may be so. It has been pointed out, however, by many observers, that the inhalation of silica dust predisposes to the development of tuberculosis, and it must be admitted that this baneful influence may have been at work in precipitating the onset of pulmonary tuberculosis, although no characteristic symptoms of silicosis had been observed.

Conclusions

1. Silicosis is caused by the inhalation of minute particles of dust of high silica content.

2. The finest particles are most directly injurious as they reach the lymphatic channels of the lung producing progressive fibrosis; the dust is most dangerous at the first moment of generation, before damping or agglutination has occurred.

3. The disease produced can be diagnosed from physical signs — in some cases before the patient has become aware of definite symptoms.

4. Silicosis predisposes to tuberculosis of the lung, as a result of the changes produced in the lung. It may, however, exist and prove fatal without any definite evidence of a superadded tuberculous infection.

5. The only means of combating the disease is by prophylaxis — in preventing the generation of dust at its source, in obviating its inhalation by the use of masks, and in excluding any affected persons when the condition becomes recognisable.

6. The prophylactic measures should be carried out in all industries where the inhalation of dust of high silica content is a contingent danger.

BIBLIOGRAPHY

1. Smyth, H. F.: A Critical Review of Methods for the Study of Dust Content of Air. Jour. Indust. Hyg., 1919–1920, **1**, 140.
2. Bill, J. P.: The Electrostatic Method of Dust Collection as Applied to the Sanitary Analysis of Air. Jour. Indust. Hyg., 1919–1920, **1**, 323.
3. Final Report of the Miners' Phthisis Prevention Committee, Pretoria, South Africa, 1919, p. 18.
4. Final Report of the Miners' Phthisis Prevention Committee, Pretoria, South Africa, 1919, p. 17, para. 44.
5. Royal Commission on Metalliferous Mines and Quarries, Minutes of Evidence, Vol. 3, Cd. 7478, p. 59. Wyman & Sons, Ltd., 1914.
6. Royal Commission on Metalliferous Mines and Quarries, Minutes of Evidence, Vol. 3, Cd. 7478, p. 145. Wyman & Sons, Ltd., 1914.
7. Mavrogordato, A.: Experiments on the Effects of Dust Inhalation. Jour. Hyg., 1918, **17**, 439.
8. Watkins-Pitchford, W.: The Gross Characters of the Silicotic Lung. Med. Jour. S. Africa, 1914–1915, **10**, 167.
9. Andrewes, F. W.: Annual Report Chief Inspector of Factories and Workshops, 1900, Cd. 668, p. 492.
10. Greenhow, E. H.: Stone-Worker's Pulmonary Disease. Trans. Path. Soc. Lond., 1866, **17**, 24.
11. Greenhow, E. H.: Specimen of Diseased Lung, from a Pearl-Shell Cutter. Trans. Path. Soc. Lond., 1870, **21**, 66.
12. Greenhow, E. H.: Specimen of Diseased Lung from a Case of Grinder's Asthma. Specimen of Coal-Miner's Black Lung. Trans. Path. Soc. Lond., 1865, **16**, 59, 60.
13. Andrewes, F. W.: Annual Report Chief Inspector of Factories and Workshops, 1900, Cd. 668, p. 493.
14. McCrae, J.: The Ash of Silicotic Lungs. General Report of Miners' Phthisis Prevention Committee, Pretoria, South Africa, 1916, p. 131.

15. Clark, *Sir* Andrew, Drs. Hadley and Chaplin: Fibroid Diseases of the Lung Including Fibroid Phthisis. London, 1894, pp. 44, 64.
16. Osler, *Sir* William: The Principles and Practice of Medicine. Sixth Edition, London, 1906, p. 632.
17. Watkins-Pitchford, W.: The Industriai Diseases of South Africa. Johannesburg, 1914, p. 35.
18. Haldane, J. S.: Text-Book of General Pathology edited by M. S. Pembrey and J. Ritchie. London and New York, 1913, p. 473.
19. Clark, *Sir* Andrew, Drs. Hadley and Chaplin: Fibroid Diseases of the Lung Including Fibroid Phthisis. London, 1894, p. 93.
20. Greenhow, E. H.: Third Report of the Medical Officer of the Privy Council, 1860, p. 144.
21. Oliver, *Sir* Thomas: Diseases of Occupation. New York, E. P. Dutton and Company, 1916, p. 280.
22. General Report of Miners' Phthisis Prevention Committee, Pretoria, South Africa, 1916, p. 104.
23. Bayne, P.: Life and Letters of Hugh Miller. London, 1871, Vol. 2, pp. 461, 472.
24. Brownlee, J.: An Investigation into the Epidemiology of Phthisis in Great Britain and Ireland, Part III. Med. Research Comm., Spec. Rep. Series, No. 46, London, 1920, p. 40.
25. Collis, E. L.: Industrial Pneumonoconioses, with Special Reference to Dust-Phthisis. Milroy Lectures (1915), p. 12. Pub. Health, 1914–15, **28**, 252.

BOOK REVIEWS

Industrial Housing. With Discussion of Accompanying Activities; Such as Town Planning — Street Systems — Development of Utility Services — and Related Engineering and Construction Features. By Morris Knowles, Sometime Supervising Engineer, Camp Meade, Maryland, and Camp M'Clellan, Alabama; and Chief Engineer, Division of Passenger Transportation and Housing, Emergency Fleet Corporation, United States Shipping Board; Member American Institute Consulting Engineers; Member American Society of Civil Engineers; Member American City Planning Institute; Member International Garden Cities and Town Planning Association; Member Town Planning Institute (Gt. Brit.); Member National Housing Association; Director, Dept. of Municipal and Sanitary Engineering, University of Pittsburgh. Cloth. Pp. 408 with illustrations and index. New York: McGraw-Hill Book Company, Inc., 1920.

Under this modest and possibly misleading title, Mr. Morris Knowles has succeeded in bringing within the compass of a single volume a connected treatise on municipal engineering in its modern aspects. With streets and pavements, water supply, sewerage and drainage, sewage treatment and disposal, collection and disposal of town wastes, and gas and electric service all comprehensively dealt with, the book may appeal at least as much to the large number interested in these subjects as to the more limited circle upon whom the housing question is pressing itself with ever increasing force.

Nor must it be supposed that the covering of this wide range of subjects has been effected by any lack of detailed treatment. Take, for instance, the discussion of street classification, pavement types and constructional methods; not only are the general principles admirably laid down, but concrete examples serve to show what can be done to meet diverse conditions. This applies also to the chapter on water supply, in which the elements of quality, necessary volume, and source of supply are treated with a completeness not always observable in separate essays. Special attention may be directed, in this connection, to the discussion of treatment methods, in which stress is laid upon the rapid growth of water filtration in the United States since 1870. In like manner, modern sewerage practice, involving to an increasing extent the separation of sewage from rainfall, is dealt with on sound principles and with an abundance of illuminating detail. The possibility of reducing leakage into pipe sewers — a too frequently neglected factor — is touched upon in references to the advantages of bituminous joint fillers over the rigid cement joint.

As regards housing, the book is largely indebted to the author's experience as supervising engineer in government camps in Maryland and Alabama and in other work during the war. A notable achievement of the U. S. Housing Corporation and the Housing and Passenger Transportation Division of the Emergency Fleet Corporation, of which division the author was chief engineer, is recorded in the erection of dwellings for more than 30,000 families at an aggregate cost of $183,000,000. Considerable space is devoted to a description, illustrated by numerous maps and plans, of what was thus accomplished. The benefits accruing from modern methods of industrial housing, including the reduction in labor turnover brought about by more settled residential conditions, are fully discussed. A review of the question of cost shows that, even with the obvious advantage of centralized control over extensive operations, dwellings of this kind entail an initial outlay of from $5000 to $6000 per family — figures excluding a total of $8111 per family in the case of the American Shipbuilding Company, Lorain, Ohio.

While the gravity of the financial problem appears to be adequately recognized by the author, we note the omission of any comprehensive discussion of the economic problem presented by the growing insistence upon state and municipal intervention in this field. Future editions of this work should include a reference to the leading example of such intervention, England and Wales, where the public exchequer faces an annual loss of $100,000,000 during the next sixty years as the result of subsidized housing.

On the other hand, the student will find invaluable data and suggestions in regard to town planning, the supervision of construction, and the administration of industrial towns. In these, as in other respects, the present treatise affords not only a demonstration of the growing importance of the subject dealt with, but a tangible proof of the skill and industry with which the results of modern experience have been made available for prospective efforts. — *John S. Hodgson.*